NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

AN INTERACTIVE COMPUTER INTERFACE
WITH A DIGITAL RECEIVER

by

William Glenn Borries

March 1977

Thesis Advisor: S. Jauregui

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

30

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) An Interactive Computer Interface with a Digital Receiver		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis March 1977
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) William Glenn Borries		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		12. REPORT DATE March 1977
		13. NUMBER OF PAGES 124
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Naval Postgraduate School Monterey, California 93940		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release: Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Register
Buffer
Interface
Digital
Computer

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A computer interface to connect both the Applied Technology Airborne Computer (ATAC) and the KIM-1 Microprocessor to a Watkins Johnson digitally tuned receiver was designed and constructed. The existing ATAC computer program was modified.

Approved for public release; distribution unlimited

An Interactive Computer Interface with a Digital Receiver

by

William Glenn Borries
Lieutenant, United States Navy
B.S., United States Naval Academy, 1970

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN ELECTRICAL ENGINEERING

from the

NAVAL POSTGRADUATE SCHOOL
March, 1977

ABSTRACT

A computer interface to connect both the Applied Technology Airborne Computer (ATAC) and the KIM-1 Microprocessor to a Watkins Johnson digitally tuned receiver was designed and constructed. The existing ATAC computer program was modified.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

A/D	Analog to Digital
ASCII	American Standard Code for Information Interchange
Baud	Bits per second
D/A	Digital to Analog
high	TTL logic 1 (+5v)
I/O	Input and/or Output
IC	Integrated Circuit
IF	Intermediate Frequency
ISB	Intermediate Sideband
low	TTL logic 0 (0v)
LSB	Lower Sideband
TTL	Transistor Transistor Logic
USB	Upper Sideband
BFO	Beat Frequency Oscillator

ACKNOWLEDGEMENTS

I would like to express my deep appreciation to Carole Hickey who wrote the initial ATAC programs. Without her Main System the programming that I did would have been unbearable. I would also like to thank the following people who have helped along the way: LT. Al May, Al Gilkes, Greg Ramos, LT. Bill Hickey, Bob Glaz, Dave Blonden, Dean Hayes, and Virginia Ward. Most importantly, I want to thank my wife, Cathy, for all the encouragement and advice she has given me during the writing of this thesis.

I. INTRODUCTION

For many decades man has dreamed of the day when machines could relieve him of much of his work. In this era of computers and advanced technology, this dream is now becoming a reality. Connecting computers to other machines, however, is not just a simple matter of running a wire from one to the other. In order for the computer to be able to use its "thinking" ability, it must have some way to translate its signals into a form that is recognized by the machine it is controlling. This is where the interface becomes all important.

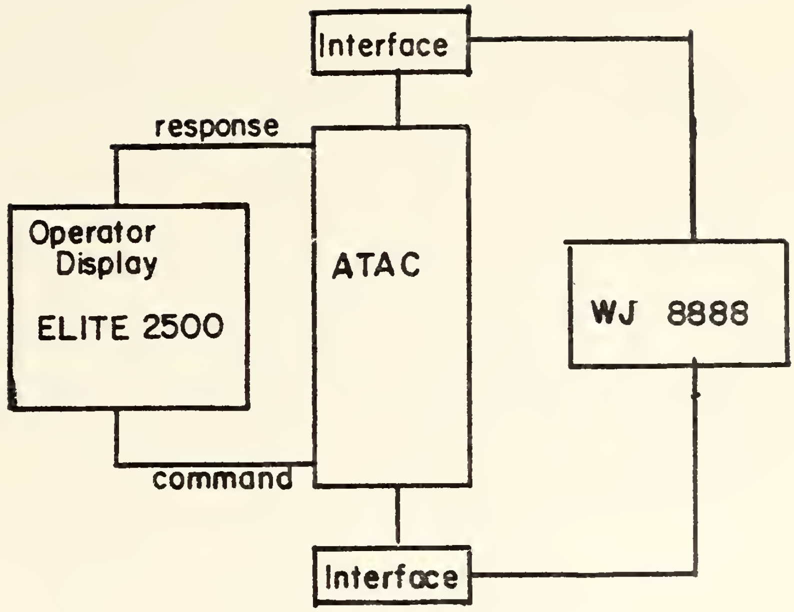
An interface is a piece of equipment placed in the data path between two devices. Its purpose is to rearrange, translate, or change the speed of this data to meet the needs of one or both devices. In other cases the interface is used to convert data from an analog to digital (A/D) or digital to analog (D/A) form, or both. Interfaces of either type range in complexity from a few integrated circuits to the use of microprocessors. Most, however, fall in between. This thesis discusses the design and construction of an interface in this middle class. Here, the computers are the Applied Technology Airborne Computer (ATAC) minicomputer and the MOS Technology Inc.'s KIM-1 microprocessor. Their goal is to program and process outputs from a digitally tunable Watkins Johnson WJ-8888.

The two computer systems arrive at their goal by

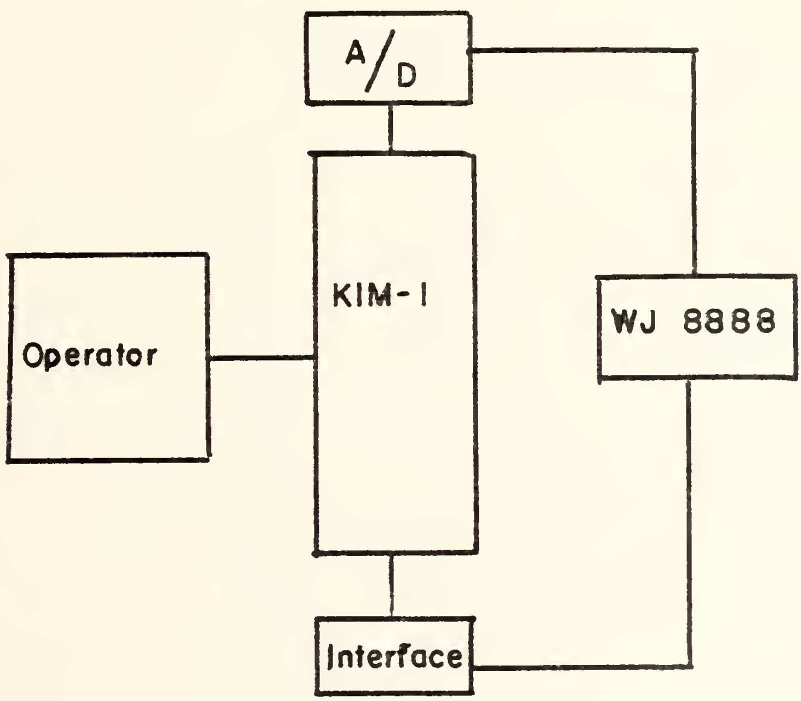
different means. The ATAC uses a closed loop with the operator (Figure 1a) while the KIM-1 excludes the operator while executing its program (Figure 1b). In the ATAC loop the operator actively controls all communication between the computer and receiver. In this way it is possible to display information from the receiver on the video display at any time except during a scan (see Chapter V). It also provides quick reference to the data to be sent, the data last sent, and latest received data. This was invaluable during debugging. From the terminal it is also possible to adjust available parameters as necessary to meet any requirement.

The KIM-1 does not directly exchange digital words with the receiver, but rather exchanges digital data for analog data. This does not provide a feedback loop that includes the operator. Once begun, the KIM-1 program selects and sends data words to the receiver and processes the analog data received until the program comes to an end or is halted by the operator. Direct information is not available to determine when or if a digital word has been sent or received correctly.

Problems encountered during the design and construction of the interface and their solutions are shown in Table I. In this instance signal level compatability was not a problem because the I/O from the receiver, the interface, and the two computers were all TTL logic levels and, therefore, matched. It is believed that these problems are a typical list that may be encountered when interfacing.



(a)



(b)

Figure 1
Computer Control

PROBLEM	SOLUTION
1. Noise on the ATAC I/O lines.	1. Use of Schottky circuits reduced or eliminated the noise.
2. Different clock rates of the computers and the receiver, and different data word lengths.	2. ATAC; converted parallel outputs into serial form. KIM-1; used interrupt lines to slave the KIM-1 to the receiver's clock.
3. Timing	3. Identified receiver periods by the Monitor Clock output. This provided a pulse which signaled stable data.
4. Inputting data to the ATAC.	4. Open collector buffers were used to sink the required current for proper data transfer.
5. Switching between the ATAC and the KIM-1.	5. Multiplexers and buffers were used to switch between the two computers.

Table I

Problems and Solutions

II. THE RECEIVER

The Watkins Johnson WJ-8888 (WJ) is an HF receiver designed for use in the 550 KHz to 30 MHz band. Its advantages include the ability to detect and output both the AM and FM IF signals while simultaneously maintaining a separate output of eight selectable detection modes. Options available to the operator include different IF bandwidths, variable RF gain, squelch control, and a tuneable BFO frequency. The WJ is digitally controlled and uses a 64-bit word as shown in Figure 2. This word contains the information necessary to transfer the frequency, detection mode, IF bandwith, RF gain, BFO frequency, and signal strength both internally and externally.

All inputs and outputs from the receiver are controlled by the synchronous, remote I/O board. This board is a gated transfer point for all digital data exchanged with the receiver. A number of control lines are needed to provide the necessary demands on the receiver. Three balanced input pairs and four balanced output line pairs, plus a ground are provided for this purpose. All three inputs are required for remote operation. They are address (or enable), trigger, and data input. The address pair is the most important for it serves as the master "on-off" switch for the remainder of the I/O pairs. The outputs furnish the required clocks (command and monitor), output data, and a local/remote status.

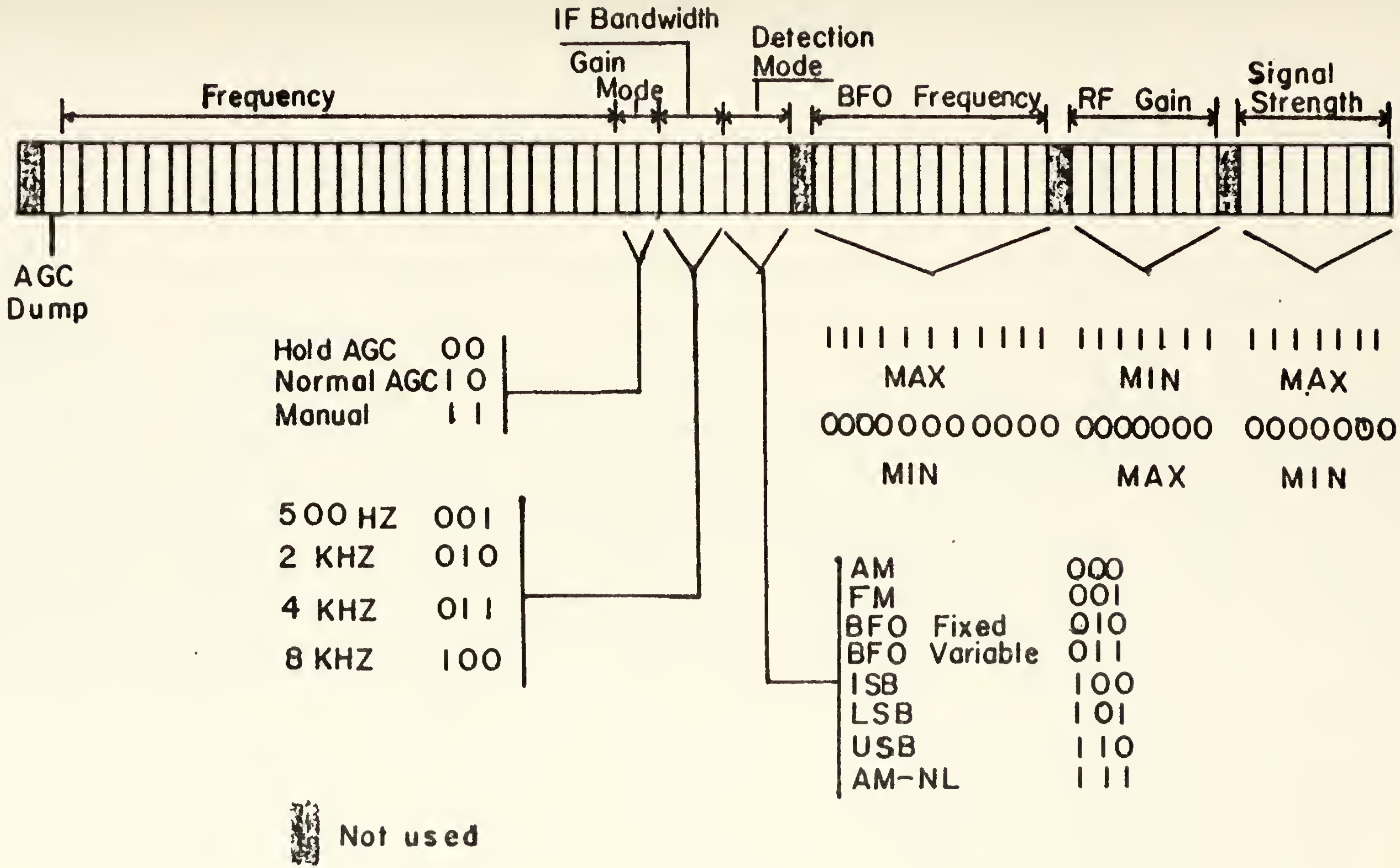


Figure 2

Receiver's Word

The Watkins Johnson operates on a sequential cycle divided into four equal periods and six identifiable modes. The periods regulate the different operations while the modes ascertain the origin of the data. Table II shows the interaction of the periods and modes of the receiver. Three of the six modes are memory read and write functions; these cannot be remotely controlled and, therefore, are of no concern here. Of the remaining three, two are the remote active and remote passive modes. These allow the introduction of externally generated data and prevent manual intervention during all but one of the four periods. Manual control is available in the remaining mode, local.

In order to manage the data word movement correctly, the receiver utilizes a common bus or data node arrangement as shown in Figure 3. This simplifies operation by forcing all data words to pass through this node in the same direction, regardless of their origin or desired destination. The multiplexer controls the input to the data node. Control of the multiplexer and, therefore, the origin of the data is managed by the internal modes of the receiver. The objective of period one is to load the receiver register. In the local and remote passive modes, the data word is shifted from the front panel register, through the multiplexer and data node, into the receiver register. The difference between these two modes is in the action of the data prior to shifting. The local mode updates the data word from the front panel storage registers during the early

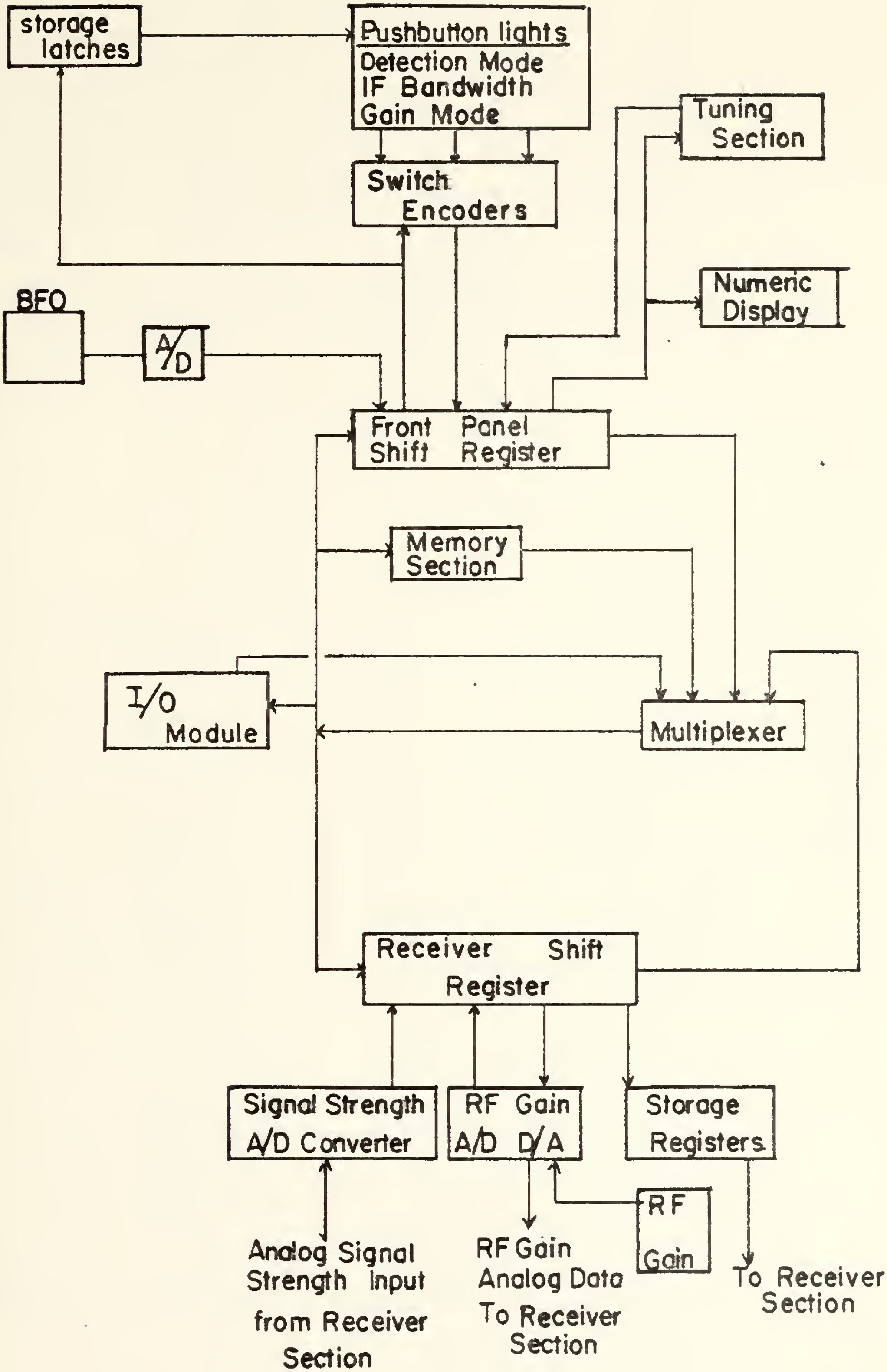


Figure 3
Block Diagram of the Digital Section

	Period 1	2	3	4
Local	Load Front Panel Reg from Front Panel/word shifted to Receiver Register	Load Rcvr Storage Req/ Signl Strength and RF gain updated /word shifted to FrontPanel Register	Display updated no words shifted	Change to Remote Active or Remote Passive possible
Remote Passive	Word shifted from FrontPanel Register to Receiver	Update only Sig Str /Load Rcvr Storage Req/word shifted to FrontPanel Reg.	Same as Local	Change to Lcl or Remote Active possible
Remote Active	Word shifted from I/O module to Receiver Register	Same as Remote Passive	Same as Local	Change to Remote Passive automatic. Change to Local possible

Table II

Receiver Modes and Periods

portion of period one. This action is inhibited during the remote passive mode. In the remote active mode the data word originates from a remote device, is shifted by the command clock through the remote I/O board, on to the receiver register via the multiplexer and data node.

The first part of the second period is spent loading the data shifted during period one into the receiver storage registers. During this time the signal strength is updated in the receiver register regardless of the mode. The RF gain A/D-D/A converter functions according to the selected mode. In the local mode the RF gain bits in the data word are replaced by A/D conversion of the front panel RF gain control knob. The two remote modes reverse this action and load the RF gain D/A converter with this data from the word. After this is completed, the word is shifted in all modes out of the receiver register, through the multiplexer and data node, and into the front panel register. If the address line from the remote device is active high, the data word and the monitor clock are available on their respective output line pairs.

Periods three and four inhibit movement of the data word. Period three updates the front panel pushbutton lights and numeric display. Period four is the only period in which changes in receiver mode are allowed. During this period changes from a remote mode to local, or from local directly to remote passive can only be accomplished by depressing the appropriate pushbutton on the front panel. A

change from local and remote passive to remote active is automatically done by the remote I/O board whenever both the address and trigger line pairs are active high during this period. The remote active mode immediately reverts to the remote passive mode at the beginning of the next period four. The total cycle time of the receiver is 10.24 msec (2.56 msec per period). In order to change modes successfully, it may be necessary either to hold in the pushbutton or to hold the trigger and address lines high for up to 7.68 msec (three periods). This ensures that the mode change demand occurs in period four.

All outputs are available from connectors J1, and J6 through J10 located on the back of the receiver. J1 is the digital I/O connector. The other connectors are all analog outputs. J6 is a 455 KHz IF signal of at least 20 KHz bandwidth. AM and FM detector monitors are provided at connectors J7 and J9 respectively. J8 is a predetection, 455 KHz center frequency IF output whose bandwidth is set by the front panel. A balanced and unbalanced line audio and both upper and lower sideband outputs are available from the appropriate pins at J10. The balanced line operates at all times. The unbalanced line is operable unless headphones are plugged into the front panel. The lower sideband output is active when the receiver is in either ISB or LSB detection modes, and the upper sideband output is active during ISB, USB, and CW modes.

III. THE COMPUTERS

After studying the inputs and outputs from the receiver, three choices were available for further development of the interface. It could be designed to pass the clock pulses on to the interrupt lines of the computer and, therefore, match the computer's timing to that of the receiver. Or, a buffer could be constructed to input the data serially at the clock rate of the computer and output it at the clock rate of the receiver. The third choice, also a buffering arrangement, could exchange data in parallel to the computer and serially to the receiver.

The chief factor influencing the design decision was the availability and distribution of computer control and I/O lines. For the first computer, the primary objective was to investigate the feasibility of both remotely tuning the receiver and accepting a data word in return. The requirements for the second computer, the MOS Technology Inc. KIM-1, were less strict. Its objective was to tune the receiver digitally through use of the interface. Its input, however, was to come from a A/D converter for processing.

A. THE ATAC

The ATAC was originally designed to provide EW service to aircraft. Built to do real-time analysis of signals, it has very short cycle times, optional microcode programming, and double precision arithmetic as part of the standard package. All this, combined with its large instruction set, makes the ATAC a versatile and powerful tool. Although data could be transferred serially by proper programming, the ability of the ATAC to both input and output sixteen bits in parallel on the PIO (parallel input/output) lines proved more advantageous. Any one of the ATAC's sixteen registers can input or output from these lines. In order to properly transfer this data, the PIO bus must be augmented by an address provided by the sixteen bits of the "extended" Arithmetic Register (XAR). Another necessary output is one that informs the external device when the ATAC is ready for the transfer. On the ATAC this function is provided by the Input/Output Demand (IOD) line. Referring to the timing diagram in Figure 4, an input command is initiated by placing an address on the XAR lines and following this address with a low on the IOD. This signifys that the ATAC register is ready for data. After approximately one microsecond, the IOD is placed high and the address is removed. During this microsecond the data for the ATAC must be stable. For an output command, the XAR and the PIO lines first present the address and data for output. When they

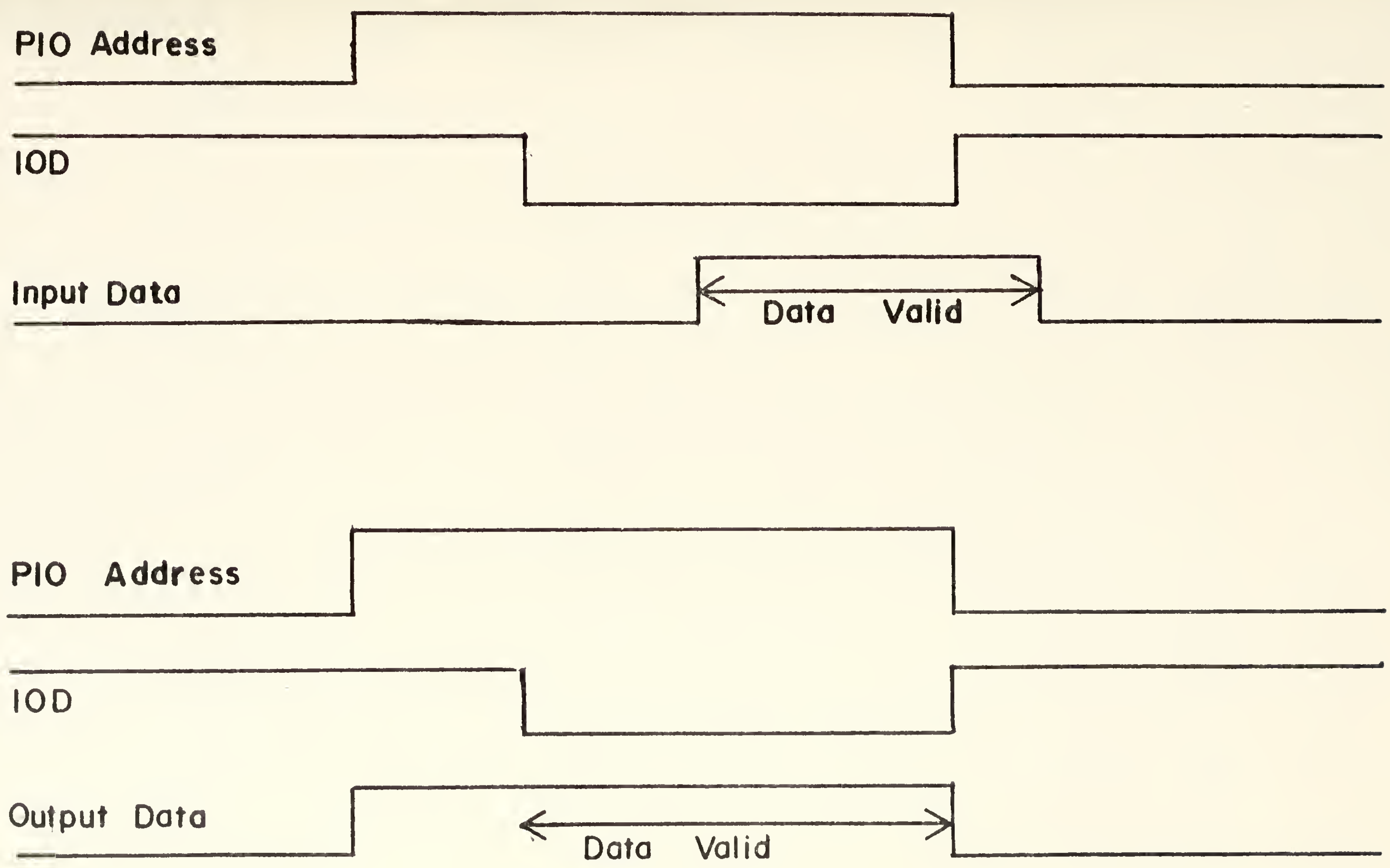


Figure 4
ATAC I/O Timing Diagram

are stable, the IOD line is set low. The data is then available for about a microsecond, as before. The IOD line is then placed high and the address and data are removed from their respective lines.

For operator interaction a serial ASCII, RS232 I/O port is also available. A Datamedia Elite 2500 television terminal is connected here to provide the operator with the necessary control and programming capablity for use of the ATAC. By proper programming and use of the XAR lines, it was possible to translate each command for the interface. Using a demultiplexer on the interface board, four of the five available XAR addresses were separated into sixteen separate commands. One of the remaining lines and the IOD line were used as strobes to identify the receiver and to signify stable data (Chapter III). This arrangement provided both the adequate isolation and flexible operation desired.

B. THE KIM-1

The KIM-1 is at the other end of the computer spectrum with respect to the ATAC. It is a microprocessor designed around the MOS Technology Inc. series MCS6500 Central Processor Unit. Complete on a single printed circuit board, the KIM-1 is simple to operate and easy to program. While its cycle time is slower than that of the ATAC, it is still much faster than the receiver and more than adequate to meet

the requirements. Since the input data came from converted analog data supplied from the receiver's FM IF output (J9) and an external A/D converter, the design for this portion of the interface was simpler.[1]

----

[1]For a more detailed discussion of the KIM-1, its objectives, programs, and operating procedures, see Signal Acquisition and Sampling Using a Microprocessor, by LT. D. Rosenberger.

IV. THE INTERFACE

The interface was initially designed solely for the ATAC. A means of converting four ATAC words into one receiver word was needed first, in order to test the program, the computer, and the receiver together. The simplest and cheapest way to accomplish this conversion and still fully utilize the capabilities of the ATAC was to build a 64-bit register using eight parallel-in, serial-out, eight-bit shift registers. A control section was also necessary to properly handle this data. The ATAC XAP addresses were decoded by this control section to provide the load commands for the registers and to signal the receiver to input the word.

The next step in construction was also simple in theory. Since the computer uses the PIO lines for input as well as output, what was needed was a connection which would not interfer with the section already built. The ICs chosen to isolate the two sections are called Tri-State. These ICs have a "no output" state in addition to the normal high and low of TTL circuits. They could not, however, sink or supply enough current to drive the computer PIO bus. A solution was found by following these ICs with open collector buffers. Not only did they provide the necessary amplification, they did not degrade the isolation performance of the Tri-States. This second section also had

a 64-bit register built from the smaller shift registers. In this case, though, they were serial-in, parallel-out. In order to remove the word from the register in sixteen-bit sections, the outputs from the shift registers were connected to four-to-one multiplexers. These multiplexers were Tri-State. With the proper control it was possible to shift the word from the receiver into this register, and transfer it to the PIO bus in the correct sequence.

Increased complexity in the control section came with this implementation. A method was needed to prevent the computer from transferring a word until it had been completely shifted into the register. The period two clock output from the receiver was used as a reference to provide a pulse to inform the computer when shifting was complete. This pulse was positioned in the same time interval as period three of the receiver. The additional benefit of identifying period four was obtained. This meant that the output for the trigger line to the receiver could be shorter and still meet the requirement to occur in a portion of period four.

After completion of the testing for the ATAC, an interface was designed and constructed for the KIM-1. This design was very simple to implement, since all the necessary timing circuits were already built and tested. The two computers were kept from interferring with each other by installation of a manual switch. This switch controls the

address of a multiplexer that separates the lines in the interface common to both computers. The control section was wire-wrapped rather than placed on a printed circuit board to provide greater flexibility, easier maintenance, and to reduce cost.

A. THE CONTROL SECTION

The heart of the interface is the control section (Figures 5 and 6). The main purpose of this section is to decode and route commands from the ATAC and provide the necessary circuits to interface with the receiver. It also contains the circuits for the operation of the receiver by the KIM-1. The receiver's outputs are driven by line drivers which provide complementary TTL levels. The inputs are applied to line receivers which accept these complementary TTL levels. The interface, therefore, had to use these same receivers and drivers to be compatable with the Watkins Johnson.

The SPST switch mounted on the front of the interface case selects the computer controlling the receiver. With the switch in the ATAC position, a high is placed on pin 1 of IC-JJ and pins 1 and 10 of IC-MM. IC-JJ is now set up to transfer the following: the address and data outputs to the line drivers on IC-LL, the trigger command to pin 2 of IC-Z, and a low in line CCK7. The CCK7 line completes the

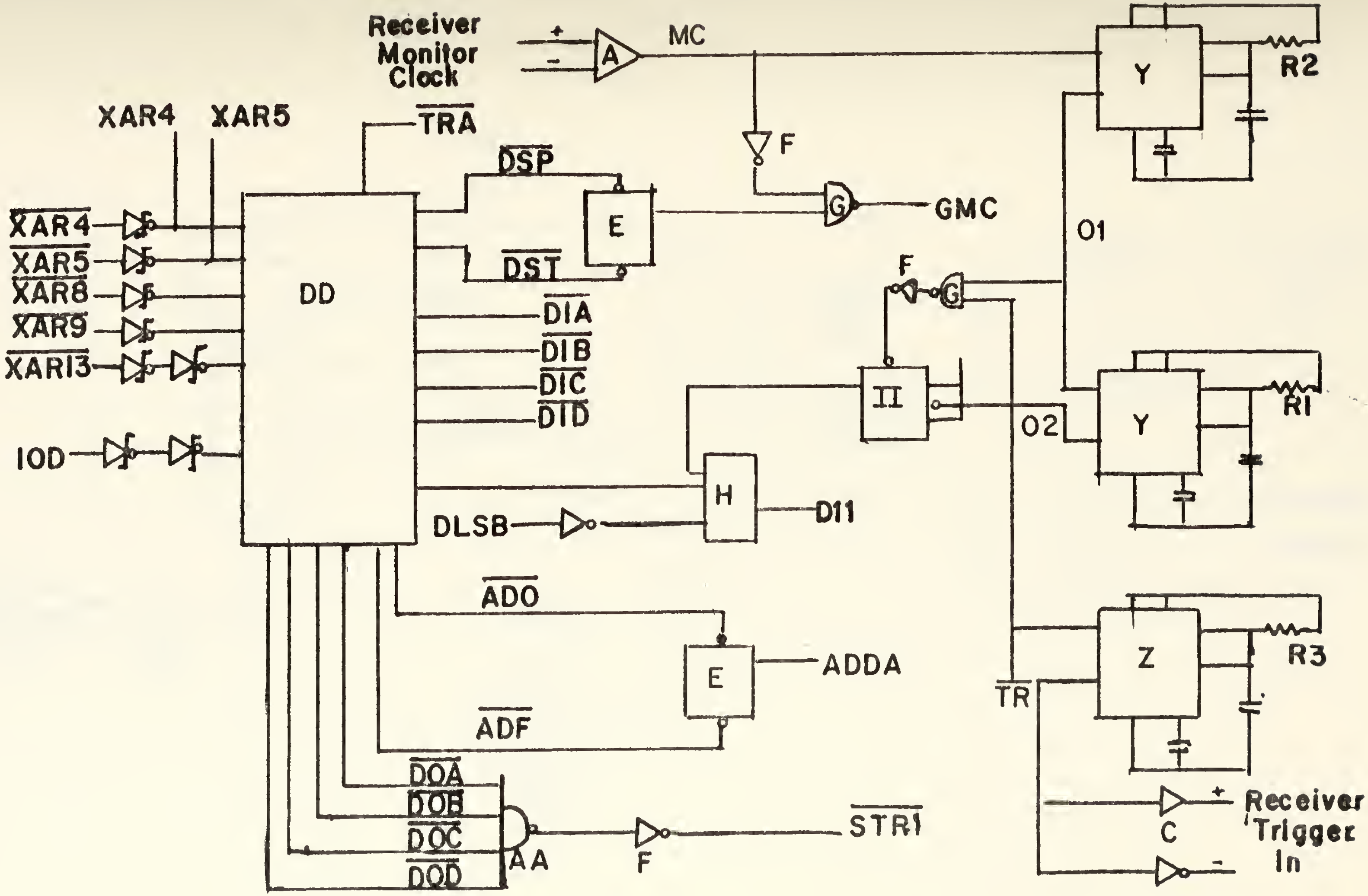


Figure 5
Interface Control Section (Part I)

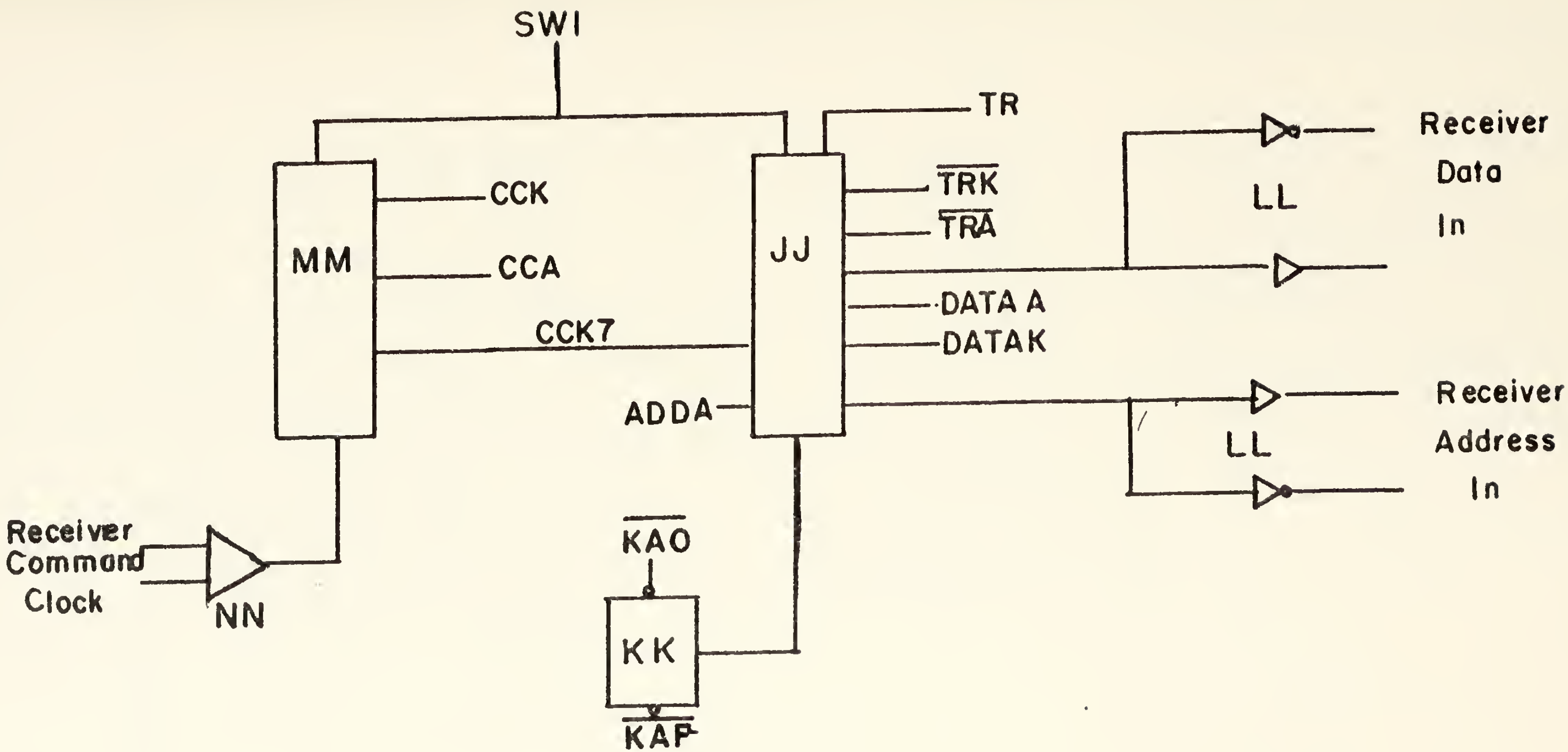


Figure 6
Interface Control Section (Part 2)

TRA	[0]	ATAC Trigger Command
DIA	[1]	Receiver input word one
DIB	[2]	Receiver input word two
DIC	[3]	Receiver input word three
DID	[4]	Receiver input word four
DSP	[5]	Stop Monitor Clock
DST	[6]	Start Monitor Clock
ADO	[7]	ATAC - Address on
DOA	[8]	Receiver output word one
DOB	[9]	Receiver output word two
DOB	[9]	Receiver output word two
DOC	[10]	Receiver output word three
DOD	[11]	Receiver output word four
RDY	[12]	Read U11 for ready signal
ADF	[15]	ATAC - Address off
TR		Receiver trigger
CCK		Kim-1 Command Clock
CCK7		Control Line for Kim-1 Command Clock
CCA		Command Clock for ATAC interface
ADDA		ATAC - Receiver Address
KADD		KIM-1 - Receiver Address
KAO		KIM-1 - Receiver Address On
KAF		KIM-1 - Receiver Address Off
TRK		KIM-1 Trigger Command

(Numbers in brackets refer to ATAC XAR commands)

Table III

Interface Command List

commands to IC-MM. This IC is a quad Tri-State buffer which is used to control the destination of the command clock. The switch opens buffer one which directs the command clock to the ATAC. The CCK7 line closes buffers two and four disabling the command clock input to the KIM-1.

The ATAC supplies the control section with six lines. Five of these are the XAR bits 4,5,8,9, and 13. Using 4, 5, 8, and 9 as address lines to pins 20-23 of IC-DD, a four-to-sixteen demultiplexer, sixteen (2^4) unique commands (Table III) were made available. The sixth line, the IOD, and XAR 13 were used as strobes or enables for the demultiplexer. In this way XAR 13 was able to specify this receiver uniquely, and the IOD ensured that addresses and data were stable before passing a command. When both IOD and XAR 13 are low, IC-DD is operational and the output corresponding to the address on pins 20-23 is forced low. At any time that either or both the two strobe lines are high, all outputs of IC-DD are held high and no commands are generated, regardless of the activity on pins 20-23.

At the beginning of the Receiver Control program (Chapter IV), the ATAC sends commands to address the receiver (ADO) and to open the gate for the monitor clock (DST). ADO places a low on pin 2 of IC-E, setting the flip-flop and forcing the ADDA line high. This line activates the receiver's I/O through ICs -JJ, -A, -B, -C, and -LL, as described above. The DST command is passed to

pin 7 of IC-E. This sets this flip-flop and allows the monitor clock (MC) to shift data from the receiver into the storage register during every period two of the receiver's cycle. The MC line is also connected directly to a timing circuit. This circuit produces the pulse described in the early part of this chapter. The first of a pair of monostable multivibrators, IC-Y (Figure 5) is triggered by the first clock pulse of MC. IC-Y outputs a pulse, interval A of timing diagram (Figure 7), which triggers the second. The second's output, interval B, is connected to pin 1 of IC-II, a negative-edge triggered, J-K flip-flop. This IC is wired so that it is set on the output of the second multivibrator and reset by either the the output of the first multivibrator or the command TR. The output of this flip-flop, pin 15, is called the RLP. This line is multiplexed with the least significant bit of the output register and inverted by IC-H for use by the ATAC on line D11.

The RLP pulse is adjustable through variable resistors (trimmers) one and two. Trimmer one controls interval B and trimmer two interval A. In effect, trimmer two varies the position of the pulse and trimmer one its width. The placement and width are the key to proper operation of the interface. The pulse must remain in period three. Although some overlap into period four is allowable it is not desirable, and any overlap into period two could cause

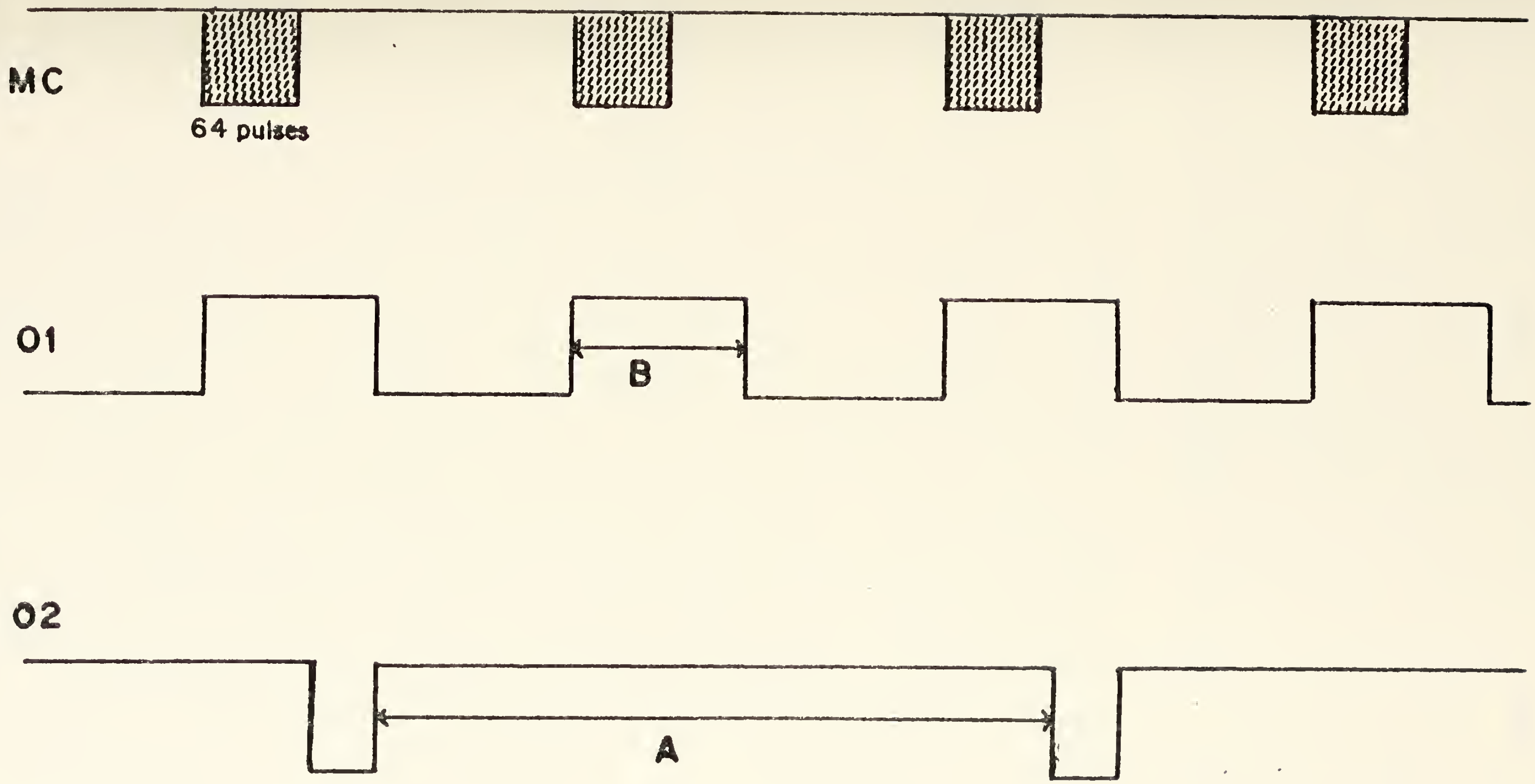


Figure 7
Interface Timing Diagram

incorrect operation. At present, the RLP pulse is programmed for every other period three. This allows the receiver to stabilize between samples taken by the computer. If more or less time is desired, the pulse can be set in every, every other, or every third period three by varying trimmer one. Greater time between pulses can be achieved by changing the .47 uF capacitor (hH-7,8) to one of larger value.

When the ATAC is ready to send a word, it loads the input register of the interface using commands DIA, DIB, DIC, DID, and then waits for a high on the D11 line. When RLP is low, D11 is high and the ATAC sends command IRA. This command is routed to a separate monostable multivibrator, IC-Z, by way of multiplexer IC-JJ. The timing circuit provides the trigger pulse in period four which changes the receiver's mode to remote active. It also sets RLP high to prevent any interaction with the ATAC until this cycle of the receiver is complete. During the following period one, the receiver sends the command clock to the input register via ICs -JJ and -MM, and inputs the data word through ICs -IJ and -LL. Meanwhile, the ATAC is waiting for RLP to go low again. When it does, the ATAC closes the MC gate with a DSP command and loads four sixteen-bit words with commands DOA, DOB, DOC, and DOD. Once the receiver word is stored in the ATAC, a DSIA command is sent to open the MC gate. When the operator has finished excution of the Receiver Control program and exits, the ATAC

sends the interface commands ADF and DSP to turn off the address line to the receiver and close the MC gate. The interface is now back in a stand-by status.

In order to set up the interface for operation with the KIM-1, the reset button must be pushed and the computer switch placed in the KIM-1 position. The reset button is unique to KIM-1 interface operation, and is necessary because of the use of the KIM-1's non-maskable interrupt. This interrupt is used to synchronize the KIM-1 with the receiver's command clock. Pressing the reset button places a momentary low on pin 5 of IC-KK, the flip-flop that controls the receiver's address line from the KIM-1. This resets the flip-flop and insures that the command clock output is disabled until required. ICs -JJ and -MM now transfer data from the KIM-1 and not the ATAC. The CCK7 line follows the address line from IC KK and gates the command clock off and on at the proper time. When the KIM-1 is ready to send a word to the receiver, it waits for a low on the RLP line. This line is connected to the maskable interrupt line. This low generates an interrupt and places the KIM-1 in the output program. This routine provides a trigger pulse for the trigger timing circuit and outputs the data synchronously with the command clock. The difference between the ATAC and KIM-1 actions of the interface is due to the position of the switch. The only function the interface serves is to provide reliable and compatible data to the appropriate device, whether it is receiver or

computer.

D. INPUT/OUTPUT REGISTERS

These two registers are used for the ATAC only. The registers were designated input or output by their related function with the receiver. They were constructed to provide the necessary, temporary storage while converting parallel and serial data back and forth. Both registers are connected to the PIO bus, with the major difference being the Tri-State connections of the serial to parallel, or output register.

The input register (Figure 8) was the easier to implement. It consists of eight 8-bit shift registers with parallel input and serial output. The parallel input comes from the ATAC's PIO bus, which is buffered by schottky inverters to reduce noise. The lines are connected to the ICs in such a way as to load words into two adjacent shift registers simultaneously. This is possible because the shift registers will only latch data in when their respective load line is low. By proper connection of the DIA-DID lines to pin 1 of the ICs, and coordinating the commands with the data, the output register can be completely and correctly filled. The command clock from the receiver is connected to pin 15 of each of the eight registers. When it is present, it clocks the data through the register exiting through pin 16 of IC-VV. From here, it goes through the control section

at IC-MM and on to the receiver.

The output register (Figure 9) performs the reverse operation. However, in order to separate it into words that are short enough for the ATAC, the data has to be multiplexed before it can be connected to the PIO bus. The Tri-State multiplexers, ICs -I through -L and -U through -X, and the required buffers, ICs -EE through -GG, were used to prevent interaction with the PIO bus when not in use. The timing here is more critical than in the input register system. Before the ATAC begins a read cycle from the output register, the clock signal to the register is stopped (DSP). This prevents the ATAC from reading non-stationary data. All the Tri-State multiplexers are addressed by connecting XAR bits 4 and 5 to pins 2 and 4 respectively. The commands DOA-DOD are ANDed together (NANDed and inverted) and the output connected to all the multiplexers as strobes at pins 1 and 15. When the ATAC reads a word, the XAR bits select the word and the strobe produces it during the microsecond when the PIO bus is available.

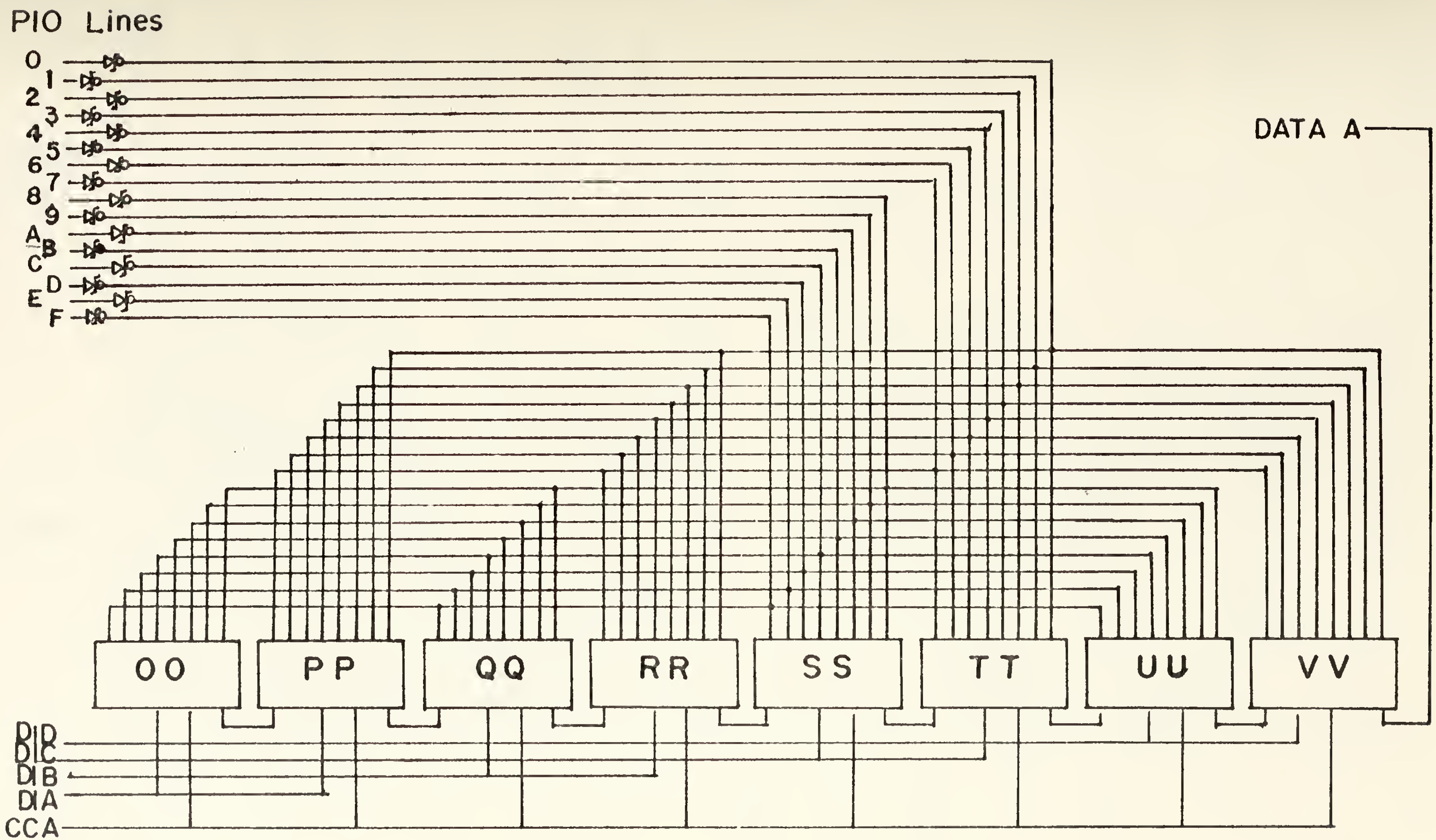


Figure 8
Input Register

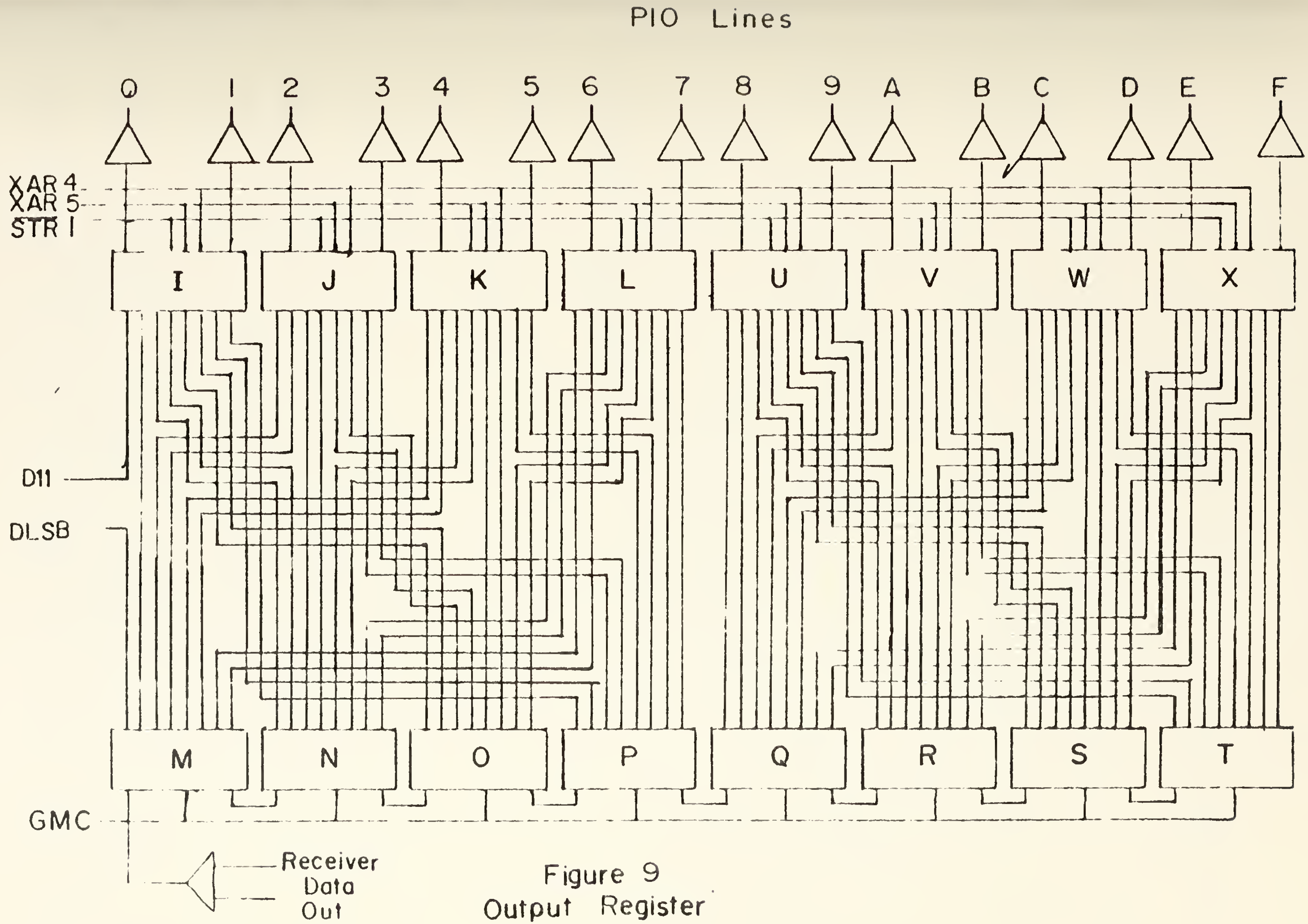


Figure 9
Output Register

V. THE PROGRAM

The ATAC program was written in two major sections; a system monitor and a control. The monitor is called the Main System and provides the operator the ability to program the ATAC from the operator's terminal. Receiver Control commands the interface and, therefore the receiver. Both programs were initially written prior to the construction of the interface, so many modifications were made using the Main System and its subroutines. After the interface was built and tested and the Receiver Control section modified to correctly contol the tuning of the receiver, the complete program was saved on paper tape (Appendix C). Operation of the computer is discussed in Appendix B and a sample run can be found in Appendix F.

A. THE MAIN SYSTEM

The Main System section consists of a small executive and a group of interconnected subroutines (Figure 10). The executive provides a basis for the subroutines when the receiver control program is not being executed. It is these subroutines that control the input and output to the operator terminal. The input routine is called KEYMR and the output routine, OUTPUT. OUTPUT converts correctly-formatted computer words into ASCII and displays them on the

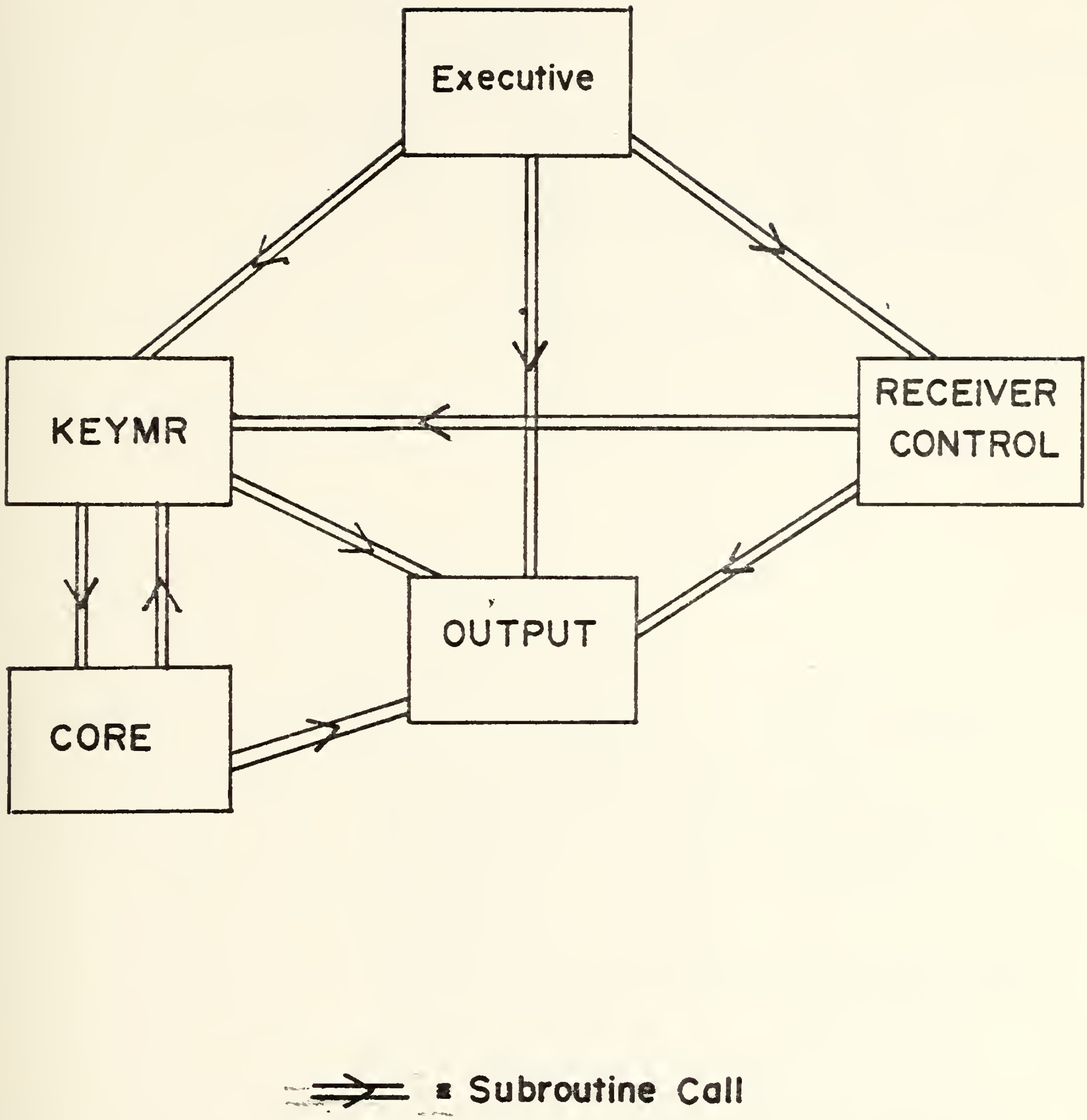


Figure 10
ATAC Program Block Diagram

I. CORE Commands

CO -- calls CORE from KEYMR.

a. DU 'address' -- displays 80 memory locations beginning with 'address'.

b. DI 'address' -- displays the contents of memory location 'address'.

c. CH 'address' 'value' -- Replaces the contents of memory at 'address' with 'value'.

d. CS 'address' -- Beginning at 'address', the contents of memory are replaced with the values typed on the lines following the command. Exit is accomplished by command DO.

e. DO -- Returns execution to CORE if in CS, otherwise returns to calling routine.

II. Receiver Control Commands

WJ -- Calls Receiver Control from the executive.

a. 0 -- Set-up - Routine to input values for entry into Receiver.

b. 1 -- Displays set-up control word.

c. 2 -- Displays last control word sent to receiver.

d. 3 -- Displays last control received from receiver.

e. 4 -- Sends set-up control word to receiver.

f. 5 -- Routine to input scan variables and execute a scan.

g. 6 -- Receive and Display control word from the receiver.

h. 7 -- Exit program and return to caller.

i. 8 -- Reinitialize program as if entering.

Table IV
ATAC Program Commands

terminal. KEYMR does the reverse, and stores the input in a buffer for use by the caller. KEYMR and OUTPUT were programmed to accept and display only uppercase letters, numerals, and a small number of needed symbols. But, because of the method employed to convert ASCII to machine code, it was found that each lower case letter entered from the keyboard was automatically mapped into its respective upper case twin. This relieves the operator of the responsibility of using the shift key. A part of the KEYMR, called COPE, is available for use by the operator to display and/or change sections of memory. The four available commands in this routine and their functions are displayed in Table IV. Care must be taken not to change memory locations which are used by the Main System. This could result in complete erasure of the ATAC's memory. Without KEYMR, OUTPUT, and COPE, or routines similiar to them, it would have been extremely difficult to perform any amount of toubleshooting or modification of the Receiver Control section.

B. RECEIVER CONTROL

This section of the system is a branch of the executive. Its main objective is to control both outputs and inputs of the interface from the operator's terminal. To assist those operators with little experience in this system, the Receiver Control section is equipped with uncomplicated

instructions and program safeguards. This produces almost foolproof operation but, it does so at the expense of program simplicity. Discussion of this section is separated into two parts. First a broad description of the complete section is discussed, followed by a detailed look at the two subroutines which interact with the interface.

When the Receiver Control program is entered, it performs five important actions. It initializes all necessary flags; enables the receiver and opens the MC gate; sends and receives a complete receiver word; and displays the instruction set to the operator. After this, it calls on KEYMR and waits for a command. When an input is delivered, the program checks its legality. If it is not a valid command, KEYMR is called again.

A valid command is a numeral between zero and eight (Table IV). These can be separated for discussion into three groups. The display group (0-3) inputs and exchanges information with the operator. The receiver group (4-6) performs operations with the receiver. The final group of commands (7-8) are used to exit or reinitialize the program. Group one has one input and three display commands. Command zero instructs the operator to input the parameters desired. It stores these parameters in memory in the display format, as opposed to control word format. Commands one, two, and three all display parameters. One displays the last parameters set-up by command zero. Two displays the last parameters sent to the receiver. Three displays the last

word received from the receiver. Commands seven and eight make up group three. Seven exits the program entirely and returns to the executive after disabling the receiver. Eight, on the other hand, returns the program to its beginning as if it had just been entered.

The remaining three commands are the most important. Group two commands control the actions of the interface. Command four converts the parameters set-up by command zero into control word format. It then calls the I/O subroutine described below, and outputs and inputs a receiver word. To merely receive a word from the receiver, command six is used. The program calls the input subroutine below and then exits to command three to display the parameters received. Command five scans a band of frequencies selected by the operator in search of a specified signal strength. All other parameters remain the same as those set-up by command zero.

With the exception of the instructions executed when entering and exiting Receiver Control, complete control of the interface and the receiver is resident in approximately forty computer instructions. These forty are grouped into the two subroutines WJR and WJS. WJS sends words to the receiver and WJR receives them. WJS loads the information and addresses to be sent to the receiver into the computer registers. The addresses are then matched to a word of data and sent to the interface input register. The routine now waits for the appropriate signal generated by RLP. When

this is received, a trigger command is sent to load the word into the receiver. At this point the routine checks the value of a counter. This test is to prevent the computer entering an infinite loop if either the interface or receiver is not turned on. If the test is unsatisfactory, the routine prints:

```
INFINITE LOOP
PLEASE CHECK RECEIVER AND INTERFACE
```

and reverts to operator control. If the test is satisfactory, the subroutine automatically continues to WJR. WJR loads another set of addresses into the computer registers. Here, a short wait for the RLP signal is necessary before any action is taken. The MC gate is closed immediately upon receipt of this signal. The receiver word is then loaded into the ATAC by outputting the address on the XAP lines and reading the data on the PIO lines. When the complete word is received, the MC gate is opened. At this point it is necessary to test for command six. This test determines whether the computer is sending and receiving or only receiving. If the execution of both WJS and WJR is being performed, a comparison between the word sent and the word received is necessary. This comparison is skipped if the computer is only executing WJR (command six). The first three control words sent by WJS and received by WJR are used for this comparison, when it is performed. If

any words differ, the computer returns to WJS to repeat the cycle until one of two conditions are met: either the words match or the WJS counter test discussed earlier fails. If the words match, WJP continues on to convert the received control words into the display format and then returns to the caller.

VI. RECOMMENDATIONS

The system as it stands now is but a beginning. Additions and modifications for future work should include; A/D converters for the receiver outputs; Morse and/or teletype decoders; and an expansion of the computer program. Implementation of either of the first two implies the third. There are some operator assistance program modifications that need to be made. The two that come immediately to mind are (1) a method to abort the scan routine from the operator's console, and (2) the ability to change individual parameters in addition to the set-up command already located in the program. Addition of the A/D converters implies a program increase to decode and process this new data. Switching routines and probably some hardware will be needed for the decoders. The capabilities of the system are limited only by the abilities of the operator and programmer.

VII. CONCLUSION

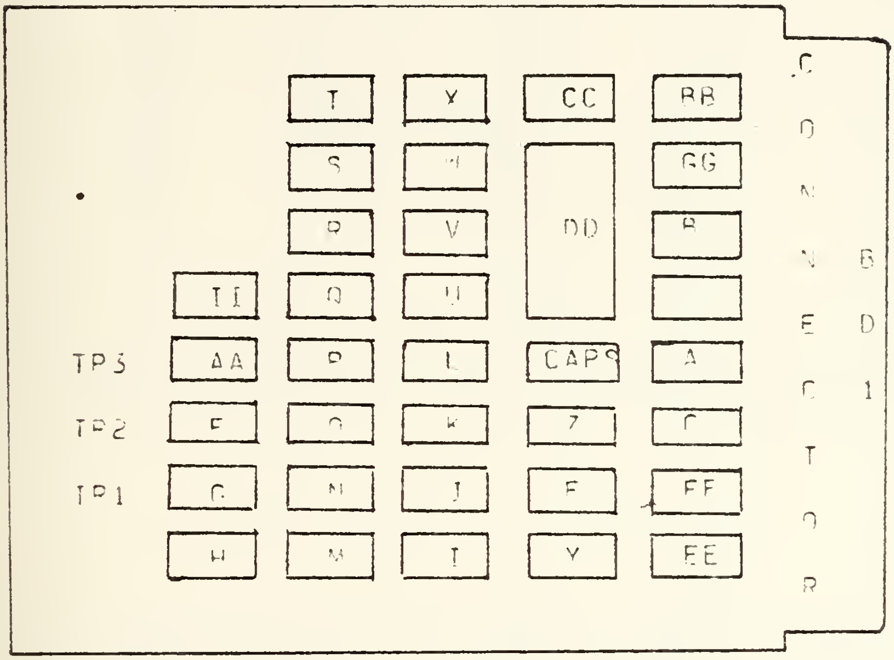
As long as the computer requires only that data obtained from the receiver's word, the interface is flexible enough to provide reliable results. At this time there are no known "bugs" in either the interface or the program. Both have been thoroughly tested to provide the operator with the most dependable system possible.

APPENDIX A

INTERFACE WIRING

A. Board 1

Integrated circuit locations (from Top of board).



Integrated Circuit

pin	A 8820	B 8820	C 8830	E 7476	F 7404	G 7400	H 74157
1	BD1-M	BD1-K	C-2/Z-3	VCC	M-3	BD2-E	DD-14
2	nc	nc	C-1/C-3	DD-8	H-3	Y-9	II-14
3	BD1-L	BD1-J	C-2/C-4	DD-15	A-6/Y-8	F-11	F-2
4	nc	nc	C-3	VCC	G-5	E-11	I-6
5	nc	nc	BD1-F	VCC	AA-6	F-4	nc
6	F-3/Y-8	M-1	BD1-H	VCC	G-12	F-9	nc
7	GRD	GRD	GRD	DD-7	GRD	GRD	GRD
8	nc	nc	nc	DD-6	I-8	nc	nc
9	nc	nc	nc	VCC	G-6	nc	nc
10	nc	nc	nc	nc	II-3	nc	nc
11	nc	nc	nc	G-4	G-3	F-13	nc
12	nc	nc	nc	VCC	I-15	F-6	nc
13	nc	nc	nc	GRD	G-11	DD-14	GRD
14	VCC	VCC	VCC	nc	VCC	VCC	VCC
15	XXXXXXX	XXXXXXX	XXXXXXX	BD1-Y	XXXXXXX	XXXXXXX	XXXXXXX
16	XXXXXXX	XXXXXXX	XXXXXXX	VCC	XXXXXXX	XXXXXXX	XXXXXXX

Integrated Circuit

	I	J	K	L	M	N
pin	7214	7214	7214	7214	74164	74164
1	X-15	I-15/J15	J-15/K15	K-15/L15	B-6/M-2	M-13/N-2
2	DD22/J-2	I-2/K-2	J-2/L-2	K-2/U-2	M-1	N-1
3	S-3	S-5	S-10	S-12	F-1	U-6
4	Q-3	Q-5	Q-10	Q-12	I-10	U-10
5	O-3	O-5	O-10	U-12	J-6	V-6
6	M-4	M-5	M-10	M-12	J-10	V-10
7	EE-1	FE-5	EF-11	FF-1	GRD	GRD
8	GRD	GRD	GRD	GRD	N-8	M-8/O-8
9	EE-3	FE-9	EF-13	FF-3	VCC	VCC
10	M-4	M-6	M-11	M-13	K-6	W-6
11	O-4	O-6	O-11	O-13	K-10	W-10
12	Q-4	Q-6	Q-11	Q-13	L-6	X-6
13	S-4	S-6	S-11	S-13	L-10	X-10
14	DD23/J14	K-14/I14	J-14/L14	K-14/U14	VCC	VCC
15	F-12/J-1	J-1/K-1	K-1/L-1	L-1/U-1	XXXXXXXX	XXXXXXXX
16	VCC	VCC	VCC	VCC	XXXXXXXX	XXXXXXXX

	O	P	Q	R	S	T
pin	74164	74164	74164	74164	74164	74164
1	N-13/O-2	O-13/P-2	P-13/Q-2	Q-13/R-2	R-13/S-2	S-13/T-2
2	O-1	P-1	Q-1	R-1	S-1	T-1
3	I-5	U-5	T-4	U-4	I-3	U-3
4	I-11	U-11	T-12	U-12	I-13	U-13
5	J-5	V-11	J-4	V-4	J-3	V-3
6	J-11	V-11	J-12	V-12	J-13	V-13
7	GRD	GRD	GRD	GRD	GRD	GRD
8	N-8/P-8	O-8/Q-8	P-8/P-8	Q-8/S-8	R-8/T-8	S-8/F-8
9	VCC	VCC	VCC	VCC	VCC	VCC
10	K-5	W-5	K-4	W-4	K-3	W-3
11	K-11	W-11	K-12	W-12	K-13	W-13
12	L-5	X-5	L-4	X-4	L-3	X-3
13	L-11	X-11	L-12	X-12	L-13	X-13
14	VCC	VCC	VCC	VCC	VCC	VCC

Integrated Circuit

pin	U 7214	V 7214	W 7214	X 7214	Y 556	Z 555
1	L-15/U15	U-15/V15	V-15/W15	W-15/X15	Y2/Tr-1A	GRD
2	L-2/V-2	U-2/W-2	V-2/X-2	W-2	Y-1/HH-6	BD1-E
3	T-3	T-5	T-10	T-12	HH-5	C-1
4	R-3	R-5	R-10	R-12	VCC	VCC
5	P-3	P-5	P-10	P-12	BD1C/II1	HH-1
6	N-3	N-5	N-10	N-12	Y-9	HH-2/Z-7
7	FF-5	FF-11	GG-1	GG-5	GRD	Z6/Tr-3A
8	GRD	GRD	GRD	GRD	A-6/F-3	VCC
9	FF-9	FF-13	GG-3	GG-9	Y-6	XXXXXXXX
10	N-4	N-6	N-11	N-13	VCC	XXXXXXXX
11	P-4	P-6	P-11	P-13	HH-4	XXXXXXXX
12	R-4	R-6	R-11	R-13	Y-13/HH4	XXXXXXXX
13	T-4	T-6	T-11	T-13	Y12/Tr2A	XXXXXXXX
14	L-14/V14	U-14/W14	V-14/X14	W-14	VCC	XXXXXXXX
15	U-1/V-1	V-1/W-1	W-1/X-1	X-1/[-1	XXXXXXXX	XXXXXXXX
16	VCC	VCC	VCC	VCC	XXXXXXXX	XXXXXXXX

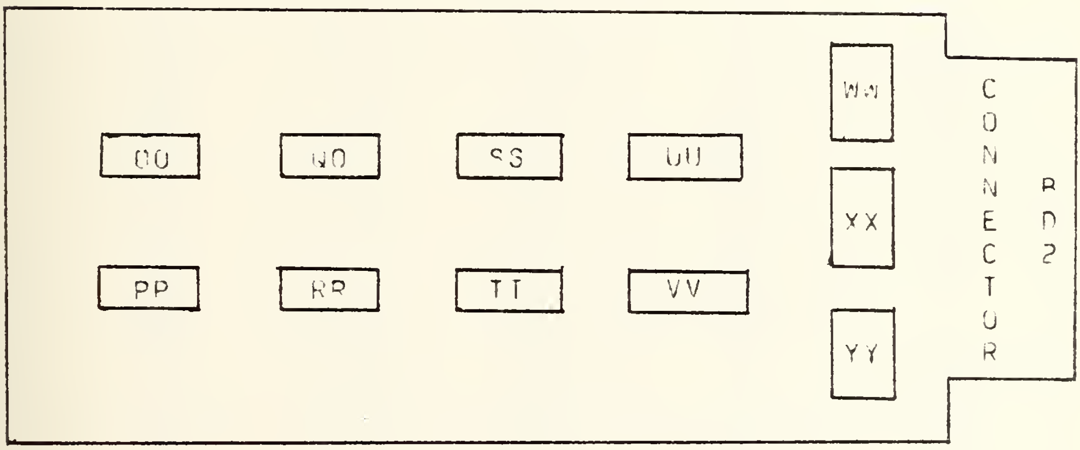
pin	AA 7420	BB 74s04	CC 74s04	EE 7407	FF 7407	GG 7407	HH CAPS	II 7476
1	DD-10	CC-6	BD1-17	T-7	L-7	W-7	Z-5	Y-5
2	DD-11	DD-18	DD-23	BD1-1	BD1-7	BD1-13	Z-6	VCC
3	nc	BD1-21	nc	T-9	L-9	W-9	Y-11	F-10
4	DD-9	BB-5	nc	BD1-2	BD1-8	BD1-14	Y-12	VCC
5	DD-13	BB-4	BD1-T	J-7	U-7	X-7	Y-3	nc
6	F-5	DD-19	BB-1	BD1-3	BD1-9	BD1-15	nc	nc
7	GRD	GRD	GRD	GRD	GRD	GRD	Y-2	nc
8	nc	DD-20	nc	BD1-4	BD1-10	BD1-16	GRD	nc
9	nc	BD1-20	nc	J-9	U-9	X-9	GRD	nc
10	nc	DD-21	nc	BD1-5	BD1-11	nc	GRD	nc
11	nc	BD1-19	nc	K-7	V-7	nc	GRD	nc
12	nc	DD-22	nc	BD1-6	BD1-12	nc	GRD	nc
13	nc	BD1-18	nc	K-9	V-9	nc	GRD	GRD
14	VCC	VCC	VCC	VCC	VCC	VCC	GRD	H-2
15	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	nc
16	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	GRD

Integrated Circuit

pin	DD 74154	pin	
1	RD1-P	13	AA-5
2	RD1-X	14	G-13/H-1
3	RD1-W	15	nc
4	RD1-V	16	nc
5	RD1-U	17	F-3
6	E-8	18	BB-2
7	E-7	19	BB-6
8	E-2	20	BB-8
9	AA-4	21	BB-10
10	AA-1	22	BB-12/I-2
11	AA-2	23	CC-2/I-14
12	GRD	24	VCC

II. Board 2

Integrated Circuit locations (from Top of board)



Integrated Circuit

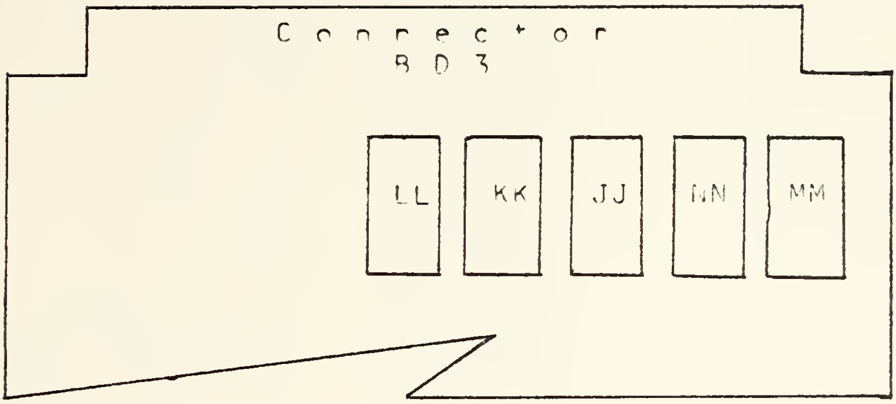
pin	OO	PP	QQ	RR	SS	TT
	74165	74165	74165	74165	74165	74165
1	BD2-A	BD2-A	BD2-B	BD2-B	BD2-C	BD2-C
2	GRD	GRD	GRD	GRD	GRD	GRD
3	WW-2	YY-6	WW-2	YY-6	WW-2	YY-6
4	WW-12	YY-4	WW-12	YY-4	WW-12	YY-4
5	WW-4	YY-2	WW-4	YY-2	WW-4	YY-2
6	WW-10	YY-10	WW-10	YY-10	WW-10	YY-10
7	nc	nc	nc	nc	nc	nc
8	GRD	GRD	GRD	GRD	GRD	GRD
9	PP-10	QQ-10	RR-10	SS-10	TT-10	UU-10
10	VCC	OO-9	PP-9	QQ-9	RR-9	SS-9
11	XX-2	XX-4	XX-2	XX-4	XX-2	XX-4
12	XX-12	XX-6	XX-12	XX-6	XX-12	XX-6
13	WW-8	XX-8	WW-8	XX-8	WW-8	XX-8
14	WW-6	YY-12	WW-6	YY-12	WW-6	YY-12
15	BD2-21	BD2-21	BD2-21	BD2-21	BD2-21	BD2-21
16	VCC	VCC	VCC	VCC	VCC	VCC

pin	UU	VV	WW	XX	YY
	74165	74165	74s04	74s04	74s04
1	BD2-D	BD2-D	BD2-17	BD2-10	BD2-4
2	GRD	GRD	OO-3 *	OO-11 *	PP-5 *
3	WW-2	YY-6	BD2-15	BD2-9	BD2-3
4	WW-12	YY-4	OO-5 *	PP-11 *	PP-4 *
5	WW-4	YY-2	BD2-13	BD2-8	BD2-2
6	WW-10	YY-10	OO-14 *	PP-12 *	PP-3 *
7	nc	nc	GRD	GRD	GRD
8	GRD	GRD	OO-13 *	PP-13 *	nc
9	VV-10	BD2-K	BD2-12	BD2-7	nc
10	TT-9	UU-9	OO-6 *	nc	PP-6 *
11	XX-2	XX-4	BD3-14	nc	BD2-5
12	XX-12	XX-6	OO-4 *	OO-12 *	PP-14 *
13	WW-8	XX-8	BD2-16	BD2-11	BD2-6
14	WW-6	YY-12	VCC	VCC	VCC
15	BD2-21	BD2-21	XYXXXYXYX	XXXXXXXXX	XXXXXXXXX
16	VCC	VCC	XXXXXYXYX	XXXXXXXXX	XXXYXXXXX

* - bus connection - only first connection shown

C. Board Three

Integrated circuit locations (from Top of board)



Integrated Circuit

	JJ	KK	LL	MM	NN
pin	74157	7476	8830	74126	8820
1	BD3-1	VCC	LL-2/JJ-7	BD3-1	BD3-5
2	KK-15	BD3-11	LL-1/LL-3	BD3-17	nc
3	BD3-6	BD3-12/20	LL-2/LL-4	BD3-16	BD3-4
4	LL-10	nc	LL-3	JJ-12	nc
5	BD3-8	VCC	BD3-7	GRD	nc
6	BD3-9	nc	BD3-10	BD3-16	MM-9
7	LL-1	nc	GRD	GRD	GRD
8	GRD	nc	BD3-19	BD3-2	nc
9	BD3-13	nc	BD3-18	NN-8	nc
10	BD3-14	nc	LL11/JJ-4	BD3-1	nc
11	nc 5	nc	LL12/LL10	BD3-3	nc
12	MM13/MM-4	nc	LL13/LL11	MM-9	nc
13	GRD	GRD	LL-12	JJ-12	nc
14	KK-15	nc	VCC	VCC	VCC
15	GRD	JJ-2/JJ14	XXXXXXXXX	XXXXXXXXX	XXXXXXXXX
16	VCC	nc	XXXXXXXXX	XXXXXXXXX	XXXXXXXXX

D. Connectors

Circuit Board Edge-connectors

	BD1	BD2	BD3
1	EE-2/BD2-10/CN1-2	GRD	SW1/JJ-1/MM-10
2	EE-4/BD2-11/CN1-3	YY-5/BD1-13	MM-8/BD2-21
3	EE-6/BD2-12/CN1-4	YY-3/BD1-14	MM-11/CN3-1
4	EE-8/BD2-13/CN1-5	YY-1/BD1-15	NN-2/CN2-2
5	EE10/BD2-17/CN1-6	YY-11/BD1-16	NN-1/CN2-3
6	EE12/BD2-16/CN1-7	YY-13/BD1-12	JJ-3/BD1-Y
7	FF-2/BD2-15/CN1-8	XX-9/BD1-11	LL-5/CN2-10
8	FF-4/BD2-14/CN1-9	XX-5/BD1-10	JJ-5/CN3-2
9	FF-6/BD2-9/CN1-10	XX-3/BD1-8	JJ-6/BD2-K
10	FF-8/BD2-8/CN1-11	XX-1/BD1-1	LL-6/CN2-11
11	FF10/BD2-7/CN1-12	XX-13/BD1-2	KK-2/CN3-3
12	FF12/BD2-6/CN1-13	WW-9/BD1-3	KK-3/CN3-4
13	GG-2/BD2-2/CN1-25	WW-5/BD1-4	JJ-9/BD1-E
14	GG-4/BD2-3/CN1-24	WW-11/BD1-8	JJ-10/BD1-P
15	GG-6/BD2-4/CN1-23	WW-3/BD1-7	JJ-11/CN3-5
16	GG-8/BD2-5/CN1-22	WW-13/BD1-6	nc
17	CC-1/CN1-11	WW-1/BD1-5	nc
18	BB-13/CN1-17	nc	LL-9/CN2-12
19	BB-11/CN1-19	nc	LL-8/CN2-11
20	BB-9/CN1-16	nc	KK-3/RESET
21	BB-3/CN1-20	OO-15/BD3-2	nc
22	nc	GRD	VCC
A	GRD	OO-1/BD1-X	GRD
B	nc	QQ-1/BD1-W	nc
C	II-14/CN3-6	SS-1/BD1-V	nc
D	nc	UU-1/BD1-U	nc
E	Z-2/BD3-13	nc	nc
F	C-5/CN2-9	nc	nc
H	C-6/CN2-8	nc	nc
J	B-3/CN2-7	nc	nc
K	B-1/CN2-6	nc	nc
L	A-3/CN2-5	nc	nc
M	A-1/CN2-4	nc	nc
N	nc	nc	nc
P	DD-1/BD3-14	nc	nc
R	nc	nc	nc
S	nc	nc	nc
T	CC-5/CN1-14	nc	nc
U	DD-5/BD2-D	nc	nc
V	DD-4/BD2-C	nc	nc
W	DD-3/BD2-B	nc	nc
X	DD-2/BD2-A	nc	nc
Y	E-15/BD3-6	nc	nc
Z	VCC	nc	nc

Cabinet Connectors

pin	CN1	CN2	CN3
1	GRD	GRD	BD3-3 "CCK"
2	BD1-1 "PIO 0"	BD3-4 "CC - "	BD3-8 "DATA K"
3	BD1-2 "PIO 1"	BD3-5 "CC + "	BD3-11 "KAO"
4	BD1-3 "PIO 2"	BD1-M "MC - "	BD3-12 "KAF"
5	BD1-4 "PIO 3"	BD1-L "MC + "	BD3-15 "TRK"
6	BD1-5 "PIO 4"	BD1-K "DO - "	BD1-3 "RLP"
7	BD1-6 "PIO 5"	BD1-J "DO + "	nc
8	BD1-7 "PIO 6"	BD1-H "TR - "	nc
9	BD1-8 "PIO 7"	BD1-F "TR + "	nc
10	BD1-9 "PIO 8"	BD3-7 "DI - "	nc
11	BD1-10 "PIO 9"	BD3-10 "DI + "	nc
12	BD1-11 "PIO 10"	BD3-19 "AD - "	nc
13	BD1-12 "PIO 11"	BD3-18 "AD + "	nc
14	BD1-T "IOD"	nc	GRD
15	nc	nc	nc
16	BD1-17 "XAR 4"	nc	nc
17	BD1-18 "XAR 5"	nc	nc
18	BD1-20 "XAR 9"	nc	nc
19	BD1-19 "XAR 8"	nc	nc
20	BD1-21 "XAR 13"	nc	nc
21	nc	nc	nc
22	BD1-16 "PIO-15"	nc	nc
23	BD1-15 "PIO-14"	nc	nc
24	BD1-14 "PIO-13"	nc	nc
25	BD1-13 "PIO-12"	nc	nc

E. Discrete Components

Capacitors

.01 uF	HH-1/HH-14
.2 uF	HH-2/HH-13
.20 uF	HH-3/HH-12
.01 uF	HH-4/HH-11
.01 uF	HH-5/HH-10
.47 uF	HH-7/HH-8

Resistors

Trimmer

	1	2	3
A	Y-1	Y-13	Z-7
B	VCC	VCC	VCC
C	VCC	VCC	VCC

APPENDIX B
ATAC OPERATING INSTRUCTIONS

Power Up
    Turn on front panel power then turn on power supplies.

Power Down
    'Halt'
    'Master Clear'
    Power off to supplies, power off to control panel.

Run Program
    'Master Clear'
    Dial 'IMR'
    'AUX REG'
    'ENTER' (associated with AUX REG)
    'MEMORY'
    Set start address +1 in keyboard (Hexadecimal)
    'PCR'
    'ENTER' (associated with PCR)
    'RUN'

Stop a Program
    'HALT'

Read Memory (from front panel)
    'HALT'
    Set desired address in key board
    Select 'MAR'
    'ENTER' (associated with MAR)
    'INC' (increment)
    'DEC' (decrement)
    Address is displayed above MAR key, data is displayed in red LEDs above MEMORY key.
    Use INC or DEC as necessary to arrive at memory location desired.

Write into Memory (from front panel)
    'HALT'
    Set address desired as described in Read Memory.
    Set desired data into keyboard
    'ENTER' (associated with MEMORY)
    Value in keyboard will be entered into either Memory (MEMORY) or A computer Register (FILE).

Bootstrap Load (paper tape)

'HALT'
'MASTER CLEAR'
'AUX REG'
Dial 'IMR'
'ENTER' (associated with AUX REG)
'MEMORY'
Set 0001 in keyboard
(0001 = Load, 0002 = Verify only)
'RUN'
At end of tape check program status lights (red LEDs below PCR and MAR pushbuttons)

0000 = Load good
FFFE = Parity error
FFFD = Verify error

APPENDIX C

ATAC PROGRAM ASSEMBLY

Assembly of a program is divided into five parts; writing, producing absolute deck on IBM 360, conversion of absolute deck into ATAC format, punching paper tape, and loading ATAC.

A. Writing the program.

Programs for the ATAC must be written in the assembly language described in ATAC manuals Volumes One, and Eight. The finished program must be placed on cards for the IBM 360 in the following format:

```
LABEL   OPERATION   VARIABLE   COMMENT
             BLANKS
```

B. Producing an absolute deck

The first step is to load the assembler on to the IBM 360 from magnetic tape. This is done by executing program A in Appendix E. This transfers the program from tape to disk and saves it for one year. Once the assembler is stored the

following cards placed in the front of a program written following the instructions in I above will produce an absolute deck and a print-out of the program.

```
//ATACASSM JOB (0729,0194,0052),'CCH ATAC ASSEM,',TIME=1
//ASSEM     EXEC PGM=APSS,REGION=220K
//STEPLIB DD  DSN=S0729.ATAC.ONE,UNIT=3330,
//               VOL=SER=DISK02,DISP=SHR
//FT06F001 DD   SYSOUT=A
//FT07F001 DD   SYSOUT=B
//FT05F001 DD   DDNAME=SYSIN
//FT08F001 DD   UNIT=SYSDA,SPACE=(CYL,1)
//FT09F001 DD   UNIT=SYSDA,SPACE=(CYL,(7,2)),
//             DCB=(RECFM=VBS,BLKSIZE=7180,LRECL=92)
//FT10F001 DD   UNIT=SYSDA,SPACE=(CYL,(7,2)),
//             DCB=(RECFM=VBS,BLKSIZE=4204,LRECL=42)
//FT20F001 DD   UNIT=SYSDA,SPACE=(CYL,(7,2)),
//             DCB=(RECFM=VBS,BLKSIZE=2004,LRECL=500)
//SYSPRINT DD   SYSOUT=A
//SYSIN    DD   *
$JOB
$ASSEM
         IDT   ATAC
```

(place written program here.)

```
         END
$BASE
$LOAD    P
$END
```

The absolute deck is in the form:

```
0500169c0009adbc3109bc9c3109c8bc7109c09c7109a8b60309bbd932/
                                                 /e10100009c015a
05101609f49c0109f6ed0008aee1010a02ed000230e10109f7ed0007ae/
                                                 /c1070509201258
```

which must be translated for the ATAC. The memory location of the first word is located in the first four columns.

Columns five and six contain the number of word fields on the card. The assembled program is located in columns 7 - 70. The remaining two columns are parity.

C. Conversion

The absolute deck received from the IBM 360 is loaded into the PDP-11. After the data from the cards is checked, the conversion program (convert 'filename' 'filename') can be executed. (Program C in Appendix F)

D. Punching Paper Tape

This code must then be transferred to the PDP-11 (A) where a paper tape can be punched. Here, the command to punch a tape is:

cat 'filename' >/dev/ptp

E. Loading the ATAC

In order to load a tape the RS232 connector must be connected to the Paper Tape reader and the reader set to 1200 baud. The tape is loaded by following the instructions in Appendix B.

APPENDIX D

SAMPLE ATAC OUTPUT

Operator inputs are underlined.

```
Operator Display                         *Comments

EXEC                                     *Executive echos
+JDKDKJFJjjnmun                          *entries other than
JDKDKJFJJJNMUH                           *commands

EXEC
+CO                                      *Entry into CORE

CORE
+CH 0F00 0900                            *Location 0F00
0F00  0900                               *changed to 0900

CORE
+DI 0F00
0F00  0900

CORE
+CS 0F00                                 *Locations  0F00 to 0F03
+0256                                    *changed

+0123

+4567

+DO                                      *completion of change
0F00  0256
0F01  0123
0F02  4567

CORE
+DO                                      *Exit from CORE

+WJ                                      *Entry into Receiver
0=SET-UP                                 *Control
1=DISPLAY TENTATIVE
2=DISPLAY CONTROL
3=DISPLAY RECEIVED
4=ENTER TENTATIVE
5=SCAN
```

```
6=RECEIVE CONTROL
7=DONE
8=REINITIALIZE

RECEIVER CONTROL
+0

FREQ(HZ)

+1240000
DETECT MODE
0=AM
1=FM
2=BFO FIXED
3=BFO VARIABLE
4=ISB
5=USB
6=LSB
7=AM-NL

+0
GAIN MODE
0=HOLD AGC
2=NORMAL AGC
3=MANUAL AGC

+0
IF BANDWIDTH
1=500 HZ
2=2 KHZ
3=4 KHZ
4=8 KHZ

+4
RF GAIN
(PERCENTAGE)

+88

RECEIVER CONTROL
+1
FREQ = 1240000 HZ
GAIN MODE = HOLD AGC
IF BANDWIDTH = 8 KHZ
DETECT MODE = AM
BFO FREQ = 455000 HZ
RF GAIN = 88%

RECEIVER CONTROL
+2
```

```
FREQ = 550000 HZ
GAIN MODE = NORMAL AGC
IF BANDWIDTH = 8 KHZ
DETECT MODE = AM
BFO FREQUENCY = 455000 HZ
RF GAIN = 85%

RECEIVER CONTROL
+3
FREQ = 550000 HZ
GAN MODE = NORMAL AGC
IF BANDWIDTH = 8 KHZ
DETECT MODE = AM
BFO FREQUENCY = 455000 HZ
RF GAIN = 85%
SIGNAL STRENGTH = 66%

RECEIVER CONTROL
+4

RECEIVER CONTROL
+5
SCAN
START FREQ IN HZ

+1000000
END FREQ IN HZ

+1008000
FREQ INCREMENT IN HZ

+1000
SIGNAL STRENGTH %

+67
FREQ = 1001000
GAIN MODE = HOLD AGC
IF BANDWIDTH = 8 KHZ
DETECT MODE = AM
BFO FREQUENCY = 455000 HZ
RF GAIN = 88%
SIGNAL STRENGTH = 72%

RECEIVER CONTROL
+7                                        *Exit from
EXEC                                      *Receiver Control
+
```

APPENDIX E

CONVERSION PROGRAMS FOR THE ASSEMBLER

A. This program is run on the IBM-360 to transfer the ATAC assembler from tape ATI-006 to Disk and stores it there for one year.

```
// [GREEN JOB CARD]
//SYSPRINT DD   SYSOUT=A
//SYSUT1   DD   UNIT=SYSDA,SPACE=(TRK,(40),,CONTIG)
//DA1      DD   UNIT=2314,DSN=S0729.ATAC.ONE,
//             SPACE=(TRK,(50,10,10),,CONTIG),
//             DISP=(NEW,KEEP),VOL=SER=SPOOL3
//I1TAPE DD UNIT=(2400,,DEFER),DISP=(NEW,PASS),
//               LABEL=(3,SL,,IN),
//             DCB=(DEN=2,BLKSIZE=800,LRECL=80,RECFM=FB),
//             VOL=SER=ATI006
//SYSIN     DD    *
         COPY   PDS=ATI.APSS.LOADLIB,TO=2314=SPOOL3,
                FROMDD=I1TAPE,FROM=2400=(ATI006,3),
                RENAME=S0729.ATAC.ONE
/*
//BUILD     EXEC PGM=IEWL,REGION=150K,
//            PARM='OVLY,XREF,LET,LIST,SIZE=(256K,20480)'
//SYSPRINT DD   SYSOUT=A
//LIBRARY DD DSN=S0729.ATAC.ONE,UNIT=2314,VOL=SER=SPOOL3,
//             DISP=SHR
//SYSLIB DD DSNAME=SYS1.FORTLIB,DISP=SHR
//SYSLMOD DD DSNAME=S0729.ATAC.ONE,
//               UNIT=3330,VOL=SER=DISK02,
//             DISP=(NEW,KEEP),LABEL=RETPD=360,
//             SPACE=(CYL,(5,1,2),RLSE)
//SYSUT1 DD UNIT=SYSDA,SPACE=(TRK,(19,19),,CONTIG),
//             SEP=SYSLMOD
//SYSLIN    DD    *
 INCLUDE LIBRARY(RMUDL)
 CHANGE MSIM(IHESAPC)
 INCLUDE LIBRARY(APSSMON)
 INCLUDE LIBRARY(MSIM4,ASEM5,SIM16A,SIMTR1,SIMIO1,GUL)
 INCLUDE LIBRARY(XPLMON)
 OVERLAY A1
 INSERT MSIMUL,*MSIMULA,IHENTRY,IHESAP
 INSERT MINT,IN,OUT
 INSERT IHEDBN,IHEXTD
```

```
 INSERT IHERSM,IHECSM
 INSERT IHERSK,IHFIOX,IHEIOP,IHEDIO,IHEDOB
 INSERT IHEDIB,IHEDOA,IHEIOB
 INSERT IHEIOA,IHEOCL
 INSERT IHERSD,IHEBSF
 INSERT IHEJXS
 INSERT IHEOSD,IHEOST,IHERST
 INSERT IHEVPF,IHEDMA,IHEVFB
 INSERT IHEDNC,IHEVFD,IHEVFA,IHEVPD,IHEVPB,IHEVSC
 INSERT IHEVSD,IHEVFE,IHEDCN,IHEUPB
 INSERT IHEVFC,IHEVPE,IHEVPG,IHEVQB,IHEVQC
 INSERT IHEABN,IHEICD,IHEIOF,IHEPRT,IHEVQA,IHESPRT
 INSERT IHEBEG,IHEEPR,IHESIZ
 INSERT MTSET
 OVERLAY A1
 INSERT ASSEM,REWIND,REW72,DSKOUT,CARDIN,DISKIN,ERPRT,PRIADD
 INSERT WRDATA,PRTCOM,PRIMOP,WRTTEX,REFTIT,PREF,ERTTT
 OVERLAY A1
 INSERT PARMRD,PRESIM
 OVERLAY A1
 INSERT SMLTR,WRMTRM,STPTSM,TPAGE
 INSERT RDCPD,ABNPMT,ARTHEP,TRACE,HGRAM,HGRAMI,HGRAMS
 INSERT IOINIT,ACTIVE,STMTIM
 INSERT DEVDTA,ACT,TIME,INT,RAND,DEADT,DEBUG
 OVERLAY A2
 INSERT LEVEL,DMAIOI,DMAIOA,DMAIOP,RIOIO
 INSERT REMACT,DMA,DMAIM,RIO,RIOTM,RIOINT,INIOLY,DMAINT
 INSERT DTRAN,PUTACT,RANDOM
 OVERLAY A1
 INSERT HGPRNT
 OVERLAY A1
 INSERT LOADER
 OVERLAY A1
 INSERT LINK,ENTEXT,SILH
 OVERLAY A1
 INSERT PLATAC,IOPACK
 OVERLAY $OBJECT(REGION)
 INSERT OBJECT,INIT,LIB,RCALPH,RCHEX,RCINT
 INSERT MDATE
 OVERLAY $DUMP(REGION)
 INSERT SMDUMP,PAGE
 ENTRY MAIN
 NAME APSS
/*
//            EXEC PGM=IEBCOPY
//SYSPRINT DD    SYSOUT=A
//SYSUT1   DD    DISP=SHR,UNIT=2314,VOL=SER=SPOOL3,
//               DSN=S0729.ATAC.ONE
//SYSUT2 DD DISP=(NEW,PASS),UNIT=3330,VOL=SER=DISK02,
//             DSN=S0729.ATAC.TWO,
```

```
//             SPACE=(13030,(61,0,14),RLSE),
//                DCB=(RECFM=U,BLKSIZE=13030),
//                ,LABEL=RETPD=360
//SYSUT3    DD    UNIT=SYSDA,SPACE=(TRK,(20,5))
//SYSUT4    DD    UNIT=SYSDA,SPACE=(TRK,(20,5))
//SYSIN     DD    *
            COPY OUTDD=SYSUT2,INDD=SYSUT1
```

d. This program converts the IBM-360 absolute deck into correct format for the ATAC.

```
main (argc, *argv)
    int argc;
    char *argv [];
    {register crctr, index, jndex;
     int stchr;
     int tmpry [73];
     struct buffr
        {int fldes;
         int nleft;
         char *nextp;
         char *buffs [512];
        } bufin, bufot, *pntr1, *pntr2;
     stchr = 020;
     if (argc != 3)
        {printf ("Calling arguments are incorrect#");
         exit (0);
        }
     bufin.fldes = open (argv [1], 0);
     if (bufin.fldes < 0)
        {printf ("Cannot open %s#", argv [1]);
         exit (0);
        }
     pntr1 = &bufin.fldes;
     bufot.fldes = creat (argv [2], 0777);
     if (bufot.fldes < 0)
        {printf ("Cannot open %s#", argv [2]);
         exit (0);
        }
     pntr2 = &bufot.fldes;
     putc (stchr, pntr2);
     while (crctr >= 0 && index <= 72)
          tmpry [index++] = (crctr = getc (pntr1));
     index =- 3;
     jndex = 0;
     while (jndex < 4 && jndex < index)
```

```
    putc (tmpry [jndex++], pntr2);
jndex = jndex + 2;
while (crctr >= 0)
   {while (jndex < index)
       {if (tmpry [jndex] == '¤')
            jndex++;
          else
            putc (tmpry [jndex++], pntr2);
       }
     index = 0;
     while (crctr >= 0 && index <= 72)
         tmpry [index++] = (crctr = getc (pntr1));
     index =- 3;
     jndex = o;
   }
putc (stchr, pntr2);
fflush (pntr2);
close (bufin.flces);
close (bufot.flces);
}
```

C. The following program executes the program above and converts the output into the correct code.

```
atac $1 $2
if ! -r $2 exit
mv $2 temp2
tr "[0*]" "[040*]" <temp2 >temp1
tr "[1*]" "[001*]" <temp1 >temp2
tr "[2*]" "[002*]" <temp2 >temp1
tr "[3*]" "[043*]" <temp1 >temp2
tr "[4*]" "[004*]" <temp2 >temp1
tr "[5*]" "[045*]" <temp1 >temp2
tr "[6*]" "[046*]" <temp2 >temp1
tr "[7*]" "[007*]" <temp1 >temp2
tr "[8*]" "[010*]" <temp2 >temp1
tr "[9*]" "[051*]" <temp1 >temp2
tr "[a*]" "[052*]" <temp2 >temp1
tr "[b*]" "[013*]" <temp1 >temp2
tr "[c*]" "[054*]" <temp2 >temp1
tr "[d*]" "[015*]" <temp1 >temp2
tr "[e*]" "[016*]" <temp2 >temp1
tr "[f*]" "[057*]" <temp1 >$2
rm temp1 temp2
```

APPENDIX F

ATAC PROGRAM

The following programs are listings of the Main System and Receiver Control programs for the ATAC. The assembly language is to the right of the absolute listing of the first three columns.

```
ATAC                                                            TIME: 15:22:49      03/21/77      PAGE    1

LOC   OBJECT CODE      CARD IMAGE                                                                 CARDNUM

                                IDT    ATAC
0000                            DS     0100
                                ENTRY  EXEC
                       WJ       EQU    0500
                       .
                       .
                       .
                       .*************************************************************
                       . EXEC                                                        *
                       .                                                             *
                       . EXECUTIVE PROGRAM FOR SYSTEM.  HANDLES REQUESTS SUBMITTED*
                       . THROUGH KEYMR                                               *
                       .*************************************************************
                       .
                       . ****************
                       . ESTABLISH EQUATES
                       . ****************
                       .
                       EADD     EQU    1                     ADDRESS OF INPUT BUFFER
                       EZ       EQU    2                     CONSTANT ZERO
                       EONE     EQU    3                     CONSTANT ONE
                       EL       EQU    4                     LOWER BYTE OF REQUEST
                       EXCAD    EQU    5                     ADDRESS OF REQUESTED ROUTINE
                       EU       EQU    6                     UPPER BYTE OF REQUEST
                       EC       EQU    7                     COUNT OF WORDS IN BUFFER
                       .
                       .
                       .
                       .
                       . *********
                       . EXECUTIVE
                       . *********
                       .
0100  E201 014D        EXEC     LDR    D,EADD,ETITLE         GET TITLE ADDRESS
0102  ED00 0230                 BAL    I,0,OUTPUT            OUTPUT TITLE
0104  ED00 0151                 BAL    I,RET,KEYMR           GET PROGRAM REQUEST
0106  9CF0 0136                 STRM   D,0,EXECS,16          SAVE ALL REGISTERS
                       .
                       . GET FIRST TWO LETTERS OF REQUEST
                       .
0108  4013                      LDR    IS,EONE,1             SET UP CONSTANT
0109  4002                      LDR    IS,EZ,0               SET UP CONSTANT
010A  5217                      LDR    RX,EC,EADD,EZ         GET COUNT OF WORDS IN BUFFER
010B  6011             EX1      ADD    IS,EADD,1             INCREMENT BUFFER POINTER
010C  5216                      LDR    RX,EU,EADD,EZ         GET WORD FROM BUFFER
010D  6FF7                      ADD    IS,EC,-1              DECREMENT WORD COUNT
010E  C106 0100                 BRCL   NP,EXEC               GET OUT IF NOT THERE
0110  2206                      CMP    IS,EU,020             COMPARE WITH SPACE
0111  C102 010B                 BRCL   EQ,EX1                IF SPACE, KEEP LOOKING
0113  AE76                      SHS    LL,EU,8               POSITION UPPER BYTE
0114  5314                      LDR    RX,EL,EADD,EONE       GET NEXT WORD IN BUFFER
0115  AE74                      SHS    LL,EL,8               CLEAR UPPER BYTE
0116  AD74                      SHS    RL,EL,8               POSITION LOWER BYTE
```

```
LOC    OBJECT CODE     CARD IMAGE                                                                    CARDNUM
0117   A446                      IOR    R,EU,EL          COMBINE FIRST TWO BYTES OF COMMAND                55
                       .                                                                                   56
0118   B106 776A                 CMP    I,EU,0776A       SEE IF REQUEST FOR WJ                             57
011A   C102 012A                 BRCL   EQ,EX2           GO CALL WJ                                        58
                       .                                                                                   59
011C   0000                      NOP                     PATCH AREA FOR ANOTHER REQUEST                    60
011D   0000                      NOP                                                                       61
011E   0000                      NOP                                                                       62
011F   0000                      NOP                                                                       63
                       .                                                                                   64
                       . ECHO EXIT - INVALID REQUEST                                                       65
                       .                                                                                   66
0120   BCF0 0136                 LDRM   D,0,EXECS,16     RESTORE REGISTERS                                 67
0122   ED00 0230                 BAL    I,0,OUTPUT       ECHO INPUT BUFFER                                 68
0124   E101 014A                 LDR    I,1,EXCRLF       GET ADDRESS OF CR/LF BUFFER                       69
0126   ED00 0230                 BAL    I,0,OUTPUT       OUTPUT CR/LF                                      70
0128   C107 0100                 BRC    I,7,EXEC         GO TRY AGAIN                                      71
                       .                                                                                   72
                       . CALL RECEIVER CONTROL PROGRAM                                                     73
                       .                                                                                   74
012A   ED00 0500       EX2       BAL    I,RET,WJ         GO TO WJ                                          75
012C   C107 0100                 BRCL   U,EXEC                                                             76
                       .                                                                                   77
                       . PATCH AREA FOR ANOTHER REQUEST                                                    78
                       .                                                                                   79
012E   0000                      NOP                                                                       80
012F   0000                      NOP                                                                       81
0130   0000                      NOP                                                                       82
0131   0000                      NOP                                                                       83
0132   0000                      NOP                                                                       84
0133   0000                      NOP                                                                       85
0134   C107 0100                 BRCL   U,EXEC                                                             86
                       .                                                                                   87
                       .                                                                                   88
                       .                                                                                   89
                       .                                                                                   90
                       . ****                                                                              91
                       . DATA                                                                              92
                       . ****                                                                              93
                       .                                                                                   94
0136                   EXECS     DS     20               SAVE AREA FOR REGISTERS                           95
                       .                                                                                   96
014A   0001            EXCRLF    DC     1                                                                  97
014B   0D0A                      DC     00D0A            CR/LF                                             98
014C   0000                      DC     0                                                                  99
014D   0003            ETITLE    DC     3                COUNT                                            100
014E   4558                      DC     04558            EX                                               101
014F   4543                      DC     04543            EC                                               102
0150   0000                      DC     0                NULL                                             103
                       .                                                                                  104
                       .                                                                                  105
                       .                                                                                  106
                       .                                                                                  107
```

```
LOC   OBJECT CODE     CARD IMAGE                                                                  
                   . ***************************************************************
                   . SYSTEM EQUATES                                                *
                   .                                                               *
                   . THESE ARE EQUATES THAT ARE USED FOR LINKAGE BETWEEN           *
                   . PROGRAMS OR THAT ARE USED BY AT LEAST TWO PROGRAMS IN         *
                   . THE SYSTEM                                                    *
                   . ***************************************************************
                   .
                   RET       EQU   0                   RETURN REGISTER
                   .
                   .
                   . ***************************************************************
                   . KEYMR                                                         *
                   .                                                               *
                   . ROUTINE TO READ DATA FROM THE KEYBOARD                        *
                   .                                                               *
                   . CALLING PROCEDURE:                                            *
                   .         BAL   I,0,KEYMR                                       *
                   .                                                               *
                   . INPUTS:                                                       *
                   .        NONE                                                   *
                   .                                                               *
                   . OUTPUTS:                                                      *
                   .     REG 1      ADDRESS OF BUFFER CONTAINING THE KEYBOARD      *
                   .                ENTRY (ONE CHARACTER PER WORD, RIGHT           *
                   .                JUSTIFIED, ASCII)                              *
                   .                THE FIRST WORD OF THE BUFFER CONTAINS THE      *
                   .                NUMBER OF CHARACTERS IN THE KEYBOARD           *
                   .                ENTRY BUFFER                                   *
                   .                                                               *
                   . ROUTINES CALLED:                                              *
                   .     OUTPUT                                                    *
                   .                                                               *
                   . THIS ROUTINE PRESERVES NO REGISTERS                           *
                   . ***************************************************************
                   .
                   .
                   . ****************
                   . ESTABLISH EQUATES
                   . ****************
                   .
                   KRET      EQU   0                   RETURN REGISTER
                   KBUF      EQU   1                   ADDRESS OF BUFFER HOLDING KEYBOARD
                   .                                   ENTRY
                   KPC       EQU   5                   POSITION COUNTER FOR NEXT INPUT
                   .                                   INPUT FROM KEYBOARD (CURSOR)
                   KPM       EQU   6                   MAX POSITION USED IN KEYBOARD ENTRY
                   .                                   (NUMBER OF CHARACTERS ENTERED)
                   KOR       EQU   7                   OUTPUT REGISTER
                   KIR       EQU   8                   INPUT REGISTER
                   KOUT      EQU   9                   OUTPUT DEVICE ADDRESS
                   KIN       EQU   10                  INPUT DEVICE ADDRESS
                   KV1       EQU   11                  VARIABLE 1
```

```
LOC   OBJECT CODE    CARD IMAGE
                     KV2      EQU   12                    VARIABLE 2
                     KV3      EQU   13                    VARIABLE 3
                     KDATA    EQU   14                    INPUT DATA FROM KEYBOARD
                     .
                     .
                     .
                     .
                     .  ********************
                     .  INITIALIZE AND SET UP
                     .  ********************
                     .
0151  9C00 01D6      KEYMR    STR   D,KRET,RETURN         SAVE RETURN ADDRESS
0153  E101 0228      KMR1     LDR   I,KBUF,KBSTRT         GET ADDRESS OF BUFFER TO OUTPUT
0155  ED00 0230               BAL   I,KRET,OUTPUT         OUTPUT INITIAL BUFFER
0157  E10A FFBF               LDR   I,KIN,0FFBF           DEVICE ADDRESS FOR INPUT
0159  E109 BFFF               LDR   I,KOUT,0BFFF          DEVICE ADDRESS FOR OUTPUT
015B  4015                    LDR   IS,KPC,1              POSITION COUNTER = 1
015C  4016                    LDR   IS,KPM,1              MAX POSITION USED = 1
015D  E101 01D7               LDR   I,KBUF,KBUFFER        ADDRESS OF BUFFER TO REGISTER
015F  E107 8000               LDR   I,KOR,08000           RESET CODE
0161  D997                    ROUT  KOR,KOUT              RESET KEYBOARD
                     .
                     .  ***************************************
                     .  SET KEYBOARD ENTRY BUFFER TO ALL SPACES
                     .  ***************************************
                     .
0162  450B                    LDR   IS,KV1,80             SET COUNTER TO BUFFER LENGTH
0163  E01C                    LDR   R,KV2,KBUF            GET BUFFER ADDRESS
0164  420D                    LDR   IS,KV3,020            CODE FOR SPACE
0165  1BCD           KMR2     STR   RX,KV3,KV2,KV1        STORE BLANK CODE
0166  6FFB                    ADD   IS,KV1,-1             DECREMENT COUNTER
0167  C101 0165               BRCL  GT,KMR2               DO AGAIN IF COUNTER GT 0
                     .
                     .  *********************
                     .  GET DATA FROM KEYBOARD
                     .  *********************
                     .
0169  E107 8000      KMR3     LDR   I,KOR,08000           RESET CODE
016B  D997                    ROUT  KOR,KOUT              RESET KEYBOARD
                     .
016C  8CAE           KMR4     RIN   KDATA,KIN             GET DATA
016D  9E0E 4000               CMPL  I,KDATA,04000         DATA PRESENT ?
016F  C105 016C               BRCL  NE,KMR4               NO DATA, WAIT
                     .
0171  E107 8000      KMR5     LDR   I,KOR,08000           RESET CODE
0173  D997                    ROUT  KOR,KOUT              RESET KEYBOARD
0174  8CA8                    RIN   KIR,KIN               GET STATUS
0175  9E08 2000               CMPL  I,KIR,02000           DATA STILL PRESENT ?
0177  C102 0171               BRCL  EQ,KMR5               KEEP TRYING TO CLEAR
                     .
                     .  *************
                     .  DATA OBTAINED
                     .  *************
```

```
LOC    OBJECT CODE     CARD IMAGE                                                                          CARDNUM
                       .                                                                                      214
0179   A10E 007F               AND    I,KDATA,0007F        SAVE DATA ONLY                                     215
                       .                                                                                      216
017B   208E                    CMP    IS,KDATA,008         COMPARE WITH BACKSPACE                             217
017C   C105 0184               BRCL   NE,KMR6              NOT BACKSPACE                                      218
017E   6FF5                    ADD    IS,KPC,-1            DECREMENT POINTER                                  219
017F   C105 0169               BRCL   NZ,KMR3              LOOK FOR DATA IF PC NOT ZERO                       220
0181   4015                    LDR    IS,KPC,1              SET PC = 1                                        221
0182   C107 0169               BRCL   U,KMR3               GET MORE DATA                                      222
                       .                                                                                      223
0184   21CE            KMR6    CMP    IS,KDATA,01C         COMPARE WITH FORWARD SPACE                         224
0185   C105 0190               BRCL   NE,KMR8              NOT FORWARD SPACE                                  225
0187   6015            KMR7    ADD    IS,KPC,1             INCREMENT POSITION COUNTER                         226
0188   B105 0050               CMP    I,KPC,80             COMPARE WITH MAX VALUE                             227
018A   C106 0169               BRCL   LE,KMR3              LESS OR EQUAL MAX, GET MORE DATA                   228
018C   E105 0050               LDR    I,KPC,80             SET POSITION COUNTER TO 80                         229
018E   C107 01B9               BRCL   U,KMR11              GET OUT OF ROUTINE                                 230
                       .                                                                                      231
0190   20DE            KMR8    CMP    IS,KDATA,00D         COMPARE WITH CARRIAGE RETURN                       232
0191   C102 01B9               BRCL   EQ,KMR11             CR, GET OUT                                        233
                       .                                                                                      234
0193   22EE                    CMP    IS,KDATA,02E         COMPARE WITH DECIMAL POINT                         235
0194   C102 01B1               BRCL   EQ,KMR10             DECIMAL POINT, PUT IN BUFFER                       236
                       .                                                                                      237
0196   220E                    CMP    IS,KDATA,020         COMPARE WITH SPACE                                 238
0197   C102 01B1               BRCL   EQ,KMR10             SPACE, PUT IN BUFFER                               239
                       .                                                                                      240
0199   230E                    CMP    IS,KDATA,030         COMPARE WITH 0                                     241
019A   C104 01AB               BRCL   LT,KMR9              ILLEGAL CHARACTER                                  242
                       .                                                                                      243
019C   239E                    CMP    IS,KDATA,039         COMPARE WITH 9                                     244
019D   C106 01B1               BRCL   LE,KMR10             NUMERIC, PUT IN BUFFER                             245
                       .                                                                                      246
019F   241E                    CMP    IS,KDATA,041         COMPARE WITH UPPER CASE A                          247
01A0   C104 01AB               BRCL   LT,KMR9              ILLEGAL CHARACTER                                  248
                       .                                                                                      249
01A2   25AE                    CMP    IS,KDATA,05A         COMPARE WITH UPPER CASE Z                          250
01A3   C106 01B1               BRCL   LE,KMR10             UPPER CASE ALPHA, PUT IN BUFFER                    251
                       .                                                                                      252
01A5   261E                    CMP    IS,KDATA,061         COMPARE WITH LOWER CASE A                          253
01A6   C104 01AB               BRCL   LT,KMR9              ILLEGAL CHARACTER                                  254
                       .                                                                                      255
01A8   27AE                    CMP    IS,KDATA,07A         COMPARE WITH LOWER CASE Z                          256
01A9   C106 01B1               BRCL   LE,KMR10             LOWER CASE ALPHA, PUT IN BUFFER                    257
                       .                                                                                      258
                       .  *************                                                                       259
                       .  ILLEGAL ENTRY                                                                       260
                       .  *************                                                                       261
                       .                                                                                      262
01AB   E101 022C       KMR9    LDR    I,KBUF,KBILL         GET ADDRESS OF ILLEGAL BUFFER                      263
01AD   ED00 0230               BAL    I,KRET,OUTPUT        OUTPUT BUFFER                                      264
01AF   C107 0153               BRCL   U,KMR1               START OVER                                         265
                       .                                                                                      266
```

```
LOC   OBJECT CODE    CARD IMAGE                                                                    CARDNUM

                     . ***************************
                     . VALID ENTRY - PUT IN BUFFER
                     . ***************************
                     .
01B1  9B5E 01D7      KMR10    STR   DX,KDATA,KBUFFER,KPC  PUT DATA IN BUFFER
01B3  B056                    CMP   R,KPM,KPC             COMPARE MAX USED WITH LAST POSITIO
01B4  C103 0187               BRCL  GE,KMR7               GO INCREMENT POSITION COUNTER
01B6  E056                    LDR   R,KPM,KPC             PM = PC
01B7  C107 0187               BRCL  U,KMR7                KEEP GETTING DATA
                     .
                     . ****
                     . EXIT
                     . ****
                     .
01B9  9C06 01D7      KMR11    STR   D,KPM,KBUFFER         PUT COUNT IN BUFFER
                     .-------------------------------------------------------------------------
                     . THIS IS THE SEQUENCE FOR CALLING 'CORE' (UTILITY TO DISPLAY AND
                     . CHANGE CORE INTERACTIVELY). ALL CODE BETWEEN DOTTED LINES MAY BE
                     . REMOVED WHEN A CALL TO THAT PROGRAM IS NO LONGER DESIRED.
01EB  E01B                    LDR   R,KV1,KBUF
01BC  4005                    LDR   IS,KPC,0
01BD  601B           KMR30    ADD   IS,KV1,1
01BE  55BC                    LDR   RX,KV2,KV1,KPC
01BF  6FF6                    ADD   IS,KPM,-1
01C0  C106 01D3               BRCL  NP,KMR12
01C2  220C                    CMP   IS,KV2,020
01C3  C102 01BD               BRCL  EQ,KMR30
01C5  601B                    ADD   IS,KV1,1
01C6  AE7C                    SHS   LL,KV2,8
01C7  55BD                    LDR   RX,KV3,KV1,KPC
01C8  AE7D                    SHS   LL,KV3,8
01C9  AD7D                    SHS   RL,KV3,8
01CA  80DC                    ADD   R,KV2,KV3
01CB  B10C 636F               CMP   I,KV2,0636F
01CD  C105 01D3               BRCL  NE,KMR12
01CF  E202 01D6               LDR   D,2,RETURN            GET ADDRESS OF CALLING ROUTINE
01D1  C107 02F8               BRC   I,7,CORE              GO PROCESS CORE REQUEST
                     .-------------------------------------------------------------------------
01D3  E200 01D6      KMR12    LDR   D,KRET,RETURN         RESTORE RETURN ADDRESS
01D5  BF07                    BRC   R,7,KRET              RETURN
                     .
                     .
                     .
                     .
                     . ****
                     . DATA
                     . ****
                     .
01D6                 RETURN   DS    1                     RETURN ADDRESS STORAGE
                     .
                     . *********************
```

```
LOC   OBJECT CODE     CARD IMAGE

                    . KEYBOARD ENTRY BUFFER
                    . *********************
                    .
01D7  0050          KBUFFER   DC     80                COUNT
01D8                          DS     80                RESERVE
                    .
                    . ******************
                    . START SYMBOL BUFFER
                    . ******************
                    .
0228  0003          KBSTRT    DC     3                 COUNT
0229  0D0A                    DC     00D0A             CR/LF
022A  002B                    DC     002B              +
022B  0000                    DC     00000             NULL
                    .
                    . **********************
                    . ILLEGAL CHARACTER BUFFER
                    . **********************
                    .
022C  0003          KBILL     DC     3                 COUNT
022D  0A07                    DC     00A07             CR,BELL
022E  0707                    DC     00707             BELL,BELL
022F  0000                    DC     00000             NULL
                    .
                    .
                    .
                    .
                    . ***********************************************************
                    . OUTPUT                                                    *
                    .                                                           *
                    . ROUTINE TO OUTPUT TO THE TTY/CRT                          *
                    .                                                           *
                    . CALLING PROCEDURE:                                        *
                    .        BAL   I,0,OUTPUT                                   *
                    .                                                           *
                    . INPUTS:                                                   *
                    .     REG 1      ADDRESS OF BUFFER TO BE OUTPUT             *
                    .                                                           *
                    . THE BUFFER MUST BE SET UP IN THE FOLLOWING MANNER:        *
                    .     WORD 1     N = NUMBER OF WORDS IN BUFFER TO BE OUTPUT *
                    .     WORDS 2-N  ASCII DATA TO BE OUTPUT, TWO ASCII         *
                    .                CHARACTERS PER WORD                        *
                    .                                                           *
                    . OUTPUTS:                                                  *
                    .     NONE                                                  *
                    .                                                           *
                    . ROUTINES CALLED:                                          *
                    .     NONE                                                  *
                    .                                                           *
                    . THIS ROUTINE PRESERVES NO REGISTERS                       *
                    . ***********************************************************
                    .
                    .
```

```
LOC   OBJECT CODE     CARD IMAGE                                                                    CARDNUM
                      . ****************                                                              373
                      . ESTABLISH EQUATES                                                             374
                      . ****************                                                              375
                      .                                                                               376
                      BUFAD     EQU   1                  ADDRESS OF BUFFER TO OUTPUT                  377
                      BO        EQU   5                  OUTPUT BUFFER ADDRESS                        378
                      VIN       EQU   6                  INPUT DEVICE ADDRESS                         379
                      VOUT      EQU   7                  OUTPUT DEVICE ADDRESS                        380
                      VL        EQU   8                  INPUT BUFFER LOWER BYTE                      381
                      VU        EQU   9                  INPUT BUFFER UPPER BYTE                      382
                      WO        EQU   10                 NUMBER OF WORDS TO OUTPUT                    383
                      WI        EQU   11                 NUMBER OF WORDS TO INPUT                     384
                      VIU       EQU   12                 UPPER BYTE INDEX                             385
                      VIL       EQU   13                 LOWER BYTE INDEX                             386
                      STAT      EQU   14                 STATUS                                       387
                      WOUT      EQU   15                 WORD TO OUTPUT TO TTY                        388
                      .                                                                               389
                      .                                                                               390
                      .                                                                               391
                      .                                                                               392
                      . ******************************                                                393
                      . INITIALIZE AND SET UP CONSTANTS                                               394
                      . ******************************                                                395
                      .                                                                               396
0230  400C            OUTPUT    LDR   IS,VIU,0           INDEX FOR STORING UPPER BYTE                 397
0231  401D                      LDR   IS,VIL,1           INDEX FOR STORING LOWER BYTE                 398
0232  E106 FFBF                 LDR   I,VIN,0FFBF        INPUT DEVICE ADDRESS                         399
0234  E107 BFFF                 LDR   I,VOUT,0BFFF       OUTPUT DEVICE ADDRESS                        400
0236  51CB                      LDR   RX,WI,VIU,BUFAD    GET INPUT WORD COUNT                         401
0237  9C0C 026A       OUT5      STR   D,VIU,COUNT        INITIALIZE COUNT                             402
0239  200B                      CMP   IS,WI,0            COMPARE WORD COUNT WITH ZERO                 403
023A  C106 0269                 BRCL  LE,OUT4            GET OUT IF COUNT LESS THAN ZERO              404
023C  228B                      CMP   IS,WI,40           COMPARE WITH MAX VALUE                       405
023D  C106 0242                 BRCL  LE,OUT3            IF IN LIMIT KEEP GOING                       406
023F  9C0B 026A                 STR   D,WI,COUNT         SAVE ORIGINAL COUNT                          407
0241  428B                      LDR   IS,WI,40           ONLY OUTPUT 40 WORDS                         408
0242  E0BA            OUT3      LDR   R,WO,WI            PUT IN OUTPUT WORD COUNT                     409
0243  AE0A                      SHS   LL,WO,1            DOUBLE FOR OUTPUT WORD COUNT                 410
0244  E105 026B                 LDR   I,BO,BUFOUT        GET OUTPUT BUFFER ADDRESS                    411
                      .                                                                               412
                      . ********************************************                                  413
                      . TRANSFER INPUT BYTE BUFFER TO OUTPUT WORD BUFFER                              414
                      . ********************************************                                  415
                      .                                                                               416
0246  6011            OUT1      ADD   IS,BUFAD,1         INCREMENT INPUT POINTER TO NEXT ENTR         417
0247  51C9                      LDR   RX,VU,VIU,BUFAD    GET INPUT WORD IN UPPER BYTE REGISTE         418
0248  E098                      LDR   R,VL,VU            PUT IN LOWER BYTE REGISTER ALSO              419
0249  AE78                      SHS   LL,VL,8            CLEAR UPPER BYTE                             420
024A  AD78                      SHS   RL,VL,8            RIGHT JUSTIFY LOWER BYTE                     421
024B  AD79                      SHS   RL,VU,8            RIGHT JUSTIFY UPPER BYTE                     422
024C  15C9                      STR   RX,VU,VIU,BO       STORE UPPER BYTE AS FULL WORD                423
                      .                                  IN THE OUTPUT BUFFER                         424
024D  15D8                      STR   RX,VL,VIL,BO       STORE LOWER BYTE AS FULL WORD                425
```

```
LOC   OBJECT CODE     CARD IMAGE                                                                   CARDNUM

                      .                              IN THE OUTPUT BUFFER
024E  6025                      ADD   IS,BO,2         INCREMENT OUTPUT BUFFER POINTER
024F  6FFB                      ADD   IS,WI,-1        DECREMENT NUMBER OF WORDS TO INPUT
0250  C101 0246                 BRCL  GT,OUT1         DO AGAIN IF NOT FINISHED
                      .
                      . *****************
                      . OUTPUT WORD BUFFER
                      . *****************
                      .
0252  E105 026B                 LDR   I,BO,BUFOUT     GET ADDRESS OF OUTPUT BUFFER
0254  8C6E            OUT2      RIN   STAT,VIN        GET STATUS
0255  9E0E 1000                 CMPL  I,STAT,01000    COMPARE STATUS
0257  C105 0254                 BRCL  NE,OUT2         WAIT IF NOT READY
0259  B75F 0000                 LLC   DX,WOUT,0,BO    GET CHARACTER TO OUTPUT
025B  A10F 01FF                 AND   I,WOUT,001FF    CLEAR ALL BUT OUTPUT DATA
025D  D97F                      ROUT  WOUT,VOUT       OUTPUT A CHARACTER
025E  6015                      ADD   IS,BO,1         INCREMENT BUFFER POINTER
025F  6FFA                      ADD   IS,WO,-1        DECREMENT WORD COUNTER
0260  C101 0254                 BRCL  GT,OUT2         GO OUTPUT ANOTHER CHARACTER
                      .
                      . ****
                      . EXIT
                      . ****
                      .
0262  F20B 026A                 LDR   D,WI,COUNT      GET EXCESS COUNT
0264  C102 0269                 BRCL  Z,OUT4          GET OUT IF ZERO
0266  6D8B                      ADD   IS,WI,-40       DECREMENT BY 40
0267  C107 0237                 BRCL  U,OUT5          DO AGAIN
C269  BF07            OUT4      BRC   R,7,RET
                      .
                      . ****
                      . DATA
                      . ****
                      .
026A                  COUNT     DS    1               SAVE LOCATION FOR EXCESS COUNT
                      .
026B                  BUFOUT    DS    80              OUTPUT BUFFER
                      .
                      .
                      .
                      .
                      . ****************************************************
                      . HEXA                                                 *
                      .                                                      *
                      . ROUTINE TO CONVERT HEX TO ASCII                      *
                      .                                                      *
                      . CALLING PROCEDURE:                                   *
                      .          BAL    I,0,HEXA                             *
                      .                                                      *
                      . INPUTS:                                              *
                      .      REG 1      HEX VALUE TO BE CONVERTED (INTEGER)  *
                      .                                                      *
                      . OUTPUTS:                                             *
```

```
LOC    OBJECT CODE      CARD IMAGE                                                                        CARDNUM
                     .      REG 2      MOST SIGNIFICANT TWO DIGITS IN ASCII          *
                     .      REG 3      LEAST SIGNIFICANT TWO DIGITS IN ASCII         *
                     .      LETTERS ARE OUTPUT IN UPPER CASE                         *
                     .                                                               *
                     .  ROUTINES CALLED:                                             *
                     .      NONE                                                     *
                     .                                                               *
                     .  THIS ROUTINE DOES NOT DISTURB REGISTERS 5 THROUGH 15         *
                     .  *************************************************************
                     .
                     .
                     .  ****************
                     .  ESTABLISH EQUATES
                     .  ****************
                     .
                     HIN       EQU    1                   HEX VALUE INPUT
                     MSD       EQU    2                   MOST SIGNIFICANT DIGITS TO OUTPUT
                     LSD       EQU    3                   LEAST SIGNIFICANT DIGITS TO OUTPUT
                     V1        EQU    4                   VARIABLE
                     .
                     .
                     .
                     .
                     .  ****************
                     .  CONVERT TO ASCII
                     .  ****************
                     .
                     .
02BB   9C00 02E1     HEXA      STR    D,RET,HEXRTN        SAVE RETURN REGISTER
02BD   E014                    LDR    R,V1,HIN            GET HEX INPUT VALUE
02BE   ADB4                    SHS    RL,V1,12            RIGHT JUSTIFY FIRST DIGIT
02BF   ED00 02DB               BAL    I,RET,HEXA1         CONVERT FIRST DIGIT
02C1   AE74                    SHS    LL,V1,8             POSITION DIGIT
02C2   E042                    LDR    R,MSD,V1            PUT IN OUTPUT REGISTER
02C3   E014                    LDR    R,V1,HIN            GET HEX INPUT VALUE
02C4   AD74                    SHS    RL,V1,8             RIGHT JUSTIFY SECOND DIGIT
02C5   A104 000F               AND    I,V1,000F           CLEAR ALL BUT SECOND DIGIT
02C7   ED00 02DB               BAL    I,RET,HEXA1         CONVERT SECOND DIGIT
02C9   8042                    ADD    R,MSD,V1            PUT IN OUTPUT REGISTER
02CA   E014                    LDR    R,V1,HIN            GET HEX INPUT VALUE
02CB   A104 00F0               AND    I,V1,00F0           CLEAR ALL BUT THIRD DIGIT
02CD   AD34                    SHS    RL,V1,4             RIGHT JUSTIFY THIRD DIGIT
02CE   ED00 02DB               BAL    I,RET,HEXA1         CONVERT THIRD DIGIT
02D0   AE74                    SHS    LL,V1,8             POSITION DIGIT
02D1   E043                    LDR    R,LSD,V1            PUT IN OUTPUT REGISTER
02D2   E014                    LDR    R,V1,HIN            GET HEX INPUT VALUE
02D3   A104 000F               AND    I,V1,0F             CLEAR ALL BUT FOURTH DIGIT
02D5   ED00 02DB               BAL    I,RET,HEXA1         CONVERT FOURTH DIGIT
02D7   8043                    ADD    R,LSD,V1            PUT IN OUTPUT REGISTER
                     .
                     .  ****
                     .  EXIT
                     .  ****
                     .
```

```
LOC   OBJECT CODE    CARD IMAGE                                                                 CARDNUM

02D8  E200 02E1              LDR    D,RET,HEXRTN            GET RETURN ADDRESS
02DA  BF07                   BRC    R,7,RET                 RETURN
                     .
                     . ****************
                     . CONVERT ONE DIGIT
                     . ****************
                     .
02DB  20A4           HEXA1   CMP    IS,V1,00A               COMPARE WITH HEX 'A'
02DC  C104 02DF              BRCL   LT,HEXA2                BRANCH IF LESS
02DE  6074                   ADD    IS,V1,7                 ADD 7 TO VALUE
02DF  6304           HEXA2   ADD    IS,V1,030               ADD HEX '30'
02E0  BF07                   BRC    R,7,RET                 GO BACK TO WHERE CALLED FROM
                     .
                     . ****
                     . DATA
                     . ****
                     .
02E1                 HEXRTN  DS     1                       SAVE LOCATION FOR RETURN ADDRESS
                     .
                     .
                     .
                     .
                     .***********************************************************
                     . AHEX                                                      *
                     .                                                           *
                     . ROUTINE TO CONVERT FOUR (4) OR LESS DIGITS IN ASCII       *
                     . CODE TO A TRUE HEX VALUE FOR THE MACHINE.  SIGN OF THE    *
                     . VALUE MUST BE HANDLED BY THE CALLING ROUTINE.             *
                     .                                                           *
                     . CALLING PROCEDURE:                                        *
                     .            BAL    I,0,AHEX                                *
                     .                                                           *
                     . INPUTS:                                                   *
                     .      REG 1      ADDRESS OF FIRST CONSECUTIVE LOCATION IN  *
                     .                 CORE WHERE THE ASCII CHARACTERS ARE LOCATED*
                     .                 (ONE CHARACTER PER CORE LOCATION)         *
                     .                                                           *
                     . OUTPUT:                                                   *
                     .      REG 2      HEX VALUE                                 *
                     .                                                           *
                     . ROUTINES CALLED:                                          *
                     .      NONE                                                 *
                     .                                                           *
                     . REGISTERS 8 THROUGH 16 ARE PRESERVED                      *
                     .***********************************************************
                     .
                     . ****************
                     . ESTABLISH EQUATES
                     . ****************
                     .
                     AHADD   EQU    1                       ADDRESS OF ASCII CHARACTERS
                     AHOUT   EQU    2                       OUTPUT HEX VALUE
                     AHV1    EQU    5                       VARIABLE 1
```

```
LOC   OBJECT CODE    CARD IMAGE                                                              CARDNUM
                     AHV2      EQU    6                     VARIABLE 2
                     AHZ       EQU    7                     ZERO
                     .
                     .
                     .
                     . *******************
                     . CONVERT ASCII TO HEX
                     . *******************
                     .
02E2  4002           AHEX      LDR    IS,AHOUT,0            CLEAR REGISTER
02E3  4045                     LDR    IS,AHV1,4             SET UP COUNTER
02E4  4007                     LDR    IS,AHZ,0              SET UP ZERO REGISTER
02E5  5176           AH1       LDR    RX,AHV2,AHZ,AHADD     GET ASCII CHARACTER
02E6  2206                     CMP    IS,AHV2,020           COMPARE WITH SPACE
02E7  C102 02F7                BRCL   EQ,AH3                DON'T TRANSLATE SPACES
02E9  AE32                     SHS    LL,AHOUT,4            MOVE DIGIT OVER
02EA  2406                     CMP    IS,AHV2,040           COMPARE WITH MIN LETTER
02EB  C104 02EE                BRCL   LT,AH2                SKIP IF NUMERIC
02ED  6096                     ADD    IS,AHV2,9             INCREMENT ALPHA
02EE  A106 000F      AH2       AND    I,AHV2,0000F          CLEAR ALL BUT DIGIT
02F0  8062                     ADD    R,AHOUT,AHV2          PUT IN OUTPUT REGISTER
02F1  6FF5                     ADD    IS,AHV1,-1            DECREMENT COUNTER
02F2  C102 02F7                BRCL   Z,AH3                 DONE
02F4  6011                     ADD    IS,AHADD,1            INCREMENT CHARACTER ADDRESS
02F5  C107 02E5                BRCL   U,AH1                 KEEP GOING
02F7  BF07           AH3       BRC    R,7,RET               GET OUT
                     .
                     .
                     .
                     .*************************************************************
                     . CORE                                                        *
                     .                                                             *
                     . ROUTINE TO CONTROL CORE INTERACTIVELY FROM THE KEYBOARD.    *
                     .                                                             *
                     .                                                             *
                     . *****WARNING*****                                           *
                     . THIS ROUTINE SHOULD ONLY BE CALLED BY 'KEYMR'. THERE ARE    *
                     . SPECIAL CONSIDERATIONS IN CALLING WHICH ARE TAKEN INTO      *
                     . ACCOUNT BY KEYMR. (TAKE SPECIAL NOTE OF REGISTER 2 WHEN     *
                     . 'CORE' IS CALLED AND THE WAY 'CORE' EXITS THROUGH 'KEYMR'   *
                     .                                                             *
                     .                                                             *
                     . MAY BE INITIATED BY THE OPERATOR AT ANY TIME WHEN THE       *
                     . KEYBOARD IS ACCEPTING DATA BY TYPING 'CORE'.   ONCE         *
                     . ENTERED, IT REMAINS IN CONTROL UNTIL RELEASED BY THE        *
                     . TYPED COMMAND 'DONE'. THE COMMANDS AND FUNCTIONS ARE        *
                     . AS LISTED:                                                  *
                     .                                                             *
                     .     COMMAND                   FUNCTION                      *
                     .                                                             *
                     .     DUMP 'ADD'                PRINTS 10 LINES OF 8 VALUES   *
```

```
LOC    OBJECT CODE      CARD IMAGE                                                                    CARDNUM
                  .                          OF CORE STARTING WITH THE       *
                  .                          ADDRESS SPECIFIED . 'ADD'       *
                  .                          MUST BE HEXIDECIMAL - ALPHA     *
                  .                          CHARACTERS IN UPPER CASE.       *
                  .                          'DUMP' MUST BE TYPED IN LOWER   *
                  .                          CASE LETTERS                    *
                  .                                                          *
                  .     CHANGE 'ADD' 'VALUE' CHANGES THE CONTENTS OF THE     *
                  .                          CORE LOCATION WHOSE ADDRESS     *
                  .                          IS SPECIFIED TO THE VALUE       *
                  .                          SPECIFIED                       *
                  .                                                          *
                  .     DISPLAY 'ADD'        DISPLAYS THE CONTENTS OF THE    *
                  .                          CORE LOCATION IN 'ADD'          *
                  .                                                          *
                  .     CS 'ADD'             INITIATES THE CHANGING OF CORE*
                  .                          SEQUENTIALLY STARTING WITH THE*
                  .                          SPECIFIED ADDRESS. AFTER THIS *
                  .                          COMMAND, THE FIRST FOUR CHARA-*
                  .                          CTERS TYPED ARE PLACED IN CORE*
                  .                          AND THE ADDRESS INCREMENTED BY*
                  .                          ONE.  THE CHANGE IS TERMINATED*
                  .                          BY TYPING 'DONE'.(THIS TYPING *
                  .                          OF 'DONE' DOES NOT CAUSE THE  *
                  .                          CORE PROGRAM TO BE EXITED)    *
                  .                                                          *
                  .                                                          *
                  . CALLING PROCEDURE:                                       *
                  .        BAL    I,0,CORE                                   *
                  .                                                          *
                  . INPUTS:                                                  *
                  .     NONE                                                 *
                  .                                                          *
                  . OUTPUTS:                                                 *
                  .     NONE                                                 *
                  .                                                          *
                  . ROUTINES CALLED:                                         *
                  .     KEYMR                                                *
                  .     OUTPUT                                               *
                  .     HEXA                                                 *
                  .     AHEX                                                 *
                  .                                                          *
                  . THIS ROUTINE PRESERVES NO REGISTERS                      *
                  .***********************************************************
                  .
                  . ****************
                  . ESTABLISH EQUATES
                  . ****************
                  .
                  CADD     EQU    1             ADDRESS OF BUFFER RETURNED .
                  CHV      EQU    1             HEX VALUE TO INPUT TO HEXA
                  CA1      EQU    2             ASCII MSD RETURNED BY HEXA
                  CA2      EQU    3             ASCII LSD RETURNED BY HEXA
```

```
LOC   OBJECT CODE     CARD IMAGE                                                                  CARDNUM
                     CV3       EQU   5                     VARIABLE 3                                  691
                     CMAX      EQU   6                     MAX NO. CHARACTERS INPUT BY KEYMR           692
                     CINDX     EQU   7                     PATH FLAG                                   693
                     CFLG      EQU   8                     BLANK FLAG                                  694
                     CF2       EQU   9                     FIELD2                                      695
                     CZERO     EQU   10                    CONSTANT 0                                  696
                     CSPACE    EQU   11                    ASCII CODE FOR SPACE                        697
                     CV1       EQU   12                    VARIABLE 1                                  698
                     CV2       EQU   13                    VARIABLE 2                                  699
                     CMD       EQU   14                    COMMAND                                     700
                     CF1       EQU   15                    FIELD 1                                     701
                     .                                                                                 702
                     .                                                                                 703
                     .                                                                                 704
                     .                                                                                 705
                     .  ******                                                                         706
                     .  SET UP                                                                         707
                     .  ******                                                                         708
                     .                                                                                 709
02F8  9C02 03D3      CORE      STR   D,2,CSAVE             SAVE REGISTER 2                             710
02FA  400C                     LDR   IS,CV1,0              GET A ZERO                                  711
02FB  9C0C 0412                STR   D,CV1,CSFLG           INITIALIZE SEQUENTIAL CHANGE FLAG           712
02FD  E101 0405      C1        LDR   I,CADD,CTITLE         GET BUFFER ADDRESS FOR TITLE                713
02FF  ED00 0230                BAL   I,RET,OUTPUT          OUTPUT TITLE                                714
0301  ED00 0151                BAL   I,RET,KEYMR           GET KEYBOARD COMMAND                        715
0303  E10B 2020                LDR   I,CSPACE,02020        SET UP SPACE CODE                           716
0305  400A                     LDR   IS,CZERO,0            SET UP ZERO CONSTANT                        717
0306  400E                     LDR   IS,CMD,0              ZERO COMMAND REGISTER                       718
0307  400F                     LDR   IS,CF1,0              ZERO FIELD 1                                719
0308  4009                     LDR   IS,CF2,0              ZERO FIELD 2                                720
0309  4008                     LDR   IS,CFLG,0             ZERO FLAG                                   721
030A  4007                     LDR   IS,CINDX,0            ZERO PATH FLAG                              722
                     .                                                                                 723
                     .  *****************                                                              724
                     .  TRANSLATE COMMAND                                                              725
                     .  *****************                                                              726
                     .                                                                                 727
030B  51A6                     LDR   RX,CMAX,CZERO,CADD    GET NO. OF ENTRIES IN BUFFER                728
030C  4008           C2        LDR   IS,CFLG,0             SET FLAG FOR READY                          729
030D  6011           C3        ADD   IS,CADD,1             INCREMENT BUFFER ADDRESS                    730
030E  6FF6                     ADD   IS,CMAX,-1            DECREMENT CHARACTER COUNTER                 731
030F  C106 0327                BRCL  NP,C6A                DONE                                        732
0311  51AC                     LDR   RX,CV1,CZERO,CADD     GET A CHARACTER FROM THE BUFFER             733
0312  220C                     CMP   IS,CV1,020            COMPARE WITH SPACE                          734
0313  C102 030C                BRCL  EQ,C2                 KEEP GOING IF SPACE                         735
0315  2008                     CMP   IS,CFLG,0             SEE IF IN MIDDLE OF ENTRY                   736
0316  C105 030D                BRCL  NE,C3                 IN ENTRY, KEEP LOOKING                      737
                     .                                                                                 738
0318  E370 031B                LDR   DX,RET,CFLD,CINDX     GET PROCESSING ADDRESS                      739
031A  BF07                     BRC   R,7,RET               PROCESS ACCORDING TO FIELD FOUND            740
                     .                                                                                 741
                     .  BRANCH TABLE                                                                   742
                     .                                                                                 743
```

```
LOC   OBJECT CODE    CARD IMAGE                                                              CARDNUM

031B  031E           CFLD     DC     C4                  COMMAND FIELD                          744
031C  0323                    DC     C5                  FIELD 1                                745
031D  0326                    DC     C6                  FIELD 2                                746
                     .                                                                          747
                     .                                                                          748
031E  E01E           C4       LDR    R,CMD,CADD          ADDRESS OF COMMAND                     749
031F  6017           C7       ADD    IS,CINDX,1          INCREMENT PATH INDEX                   750
0320  4FF8                    LDR    IS,CFLG,-1          SET FLAG FOR IN ENTRY                  751
0321  C107 030D               BRCL   U,C3                KEEP GOING                             752
0323  E01F           C5       LDR    R,CF1,CADD          ADDRESS OF FIELD 1                     753
0324  C107 031F               BRCL   U,C7                KEEP GOING                             754
0326  E019           C6       LDR    R,CF2,CADD          ADDRESS OF FIELD 2                     755
                     .                                                                          756
                     .                                                                          757
0327  200F           C6A      CMP    IS,CF1,0            SEE IF FIELD 1 IS PRESENT              758
0328  C102 0335               BRCL   EQ,C8               GO PROCESS COMMAND ONLY                759
                     .                                                                          760
                     . CONVERT FIELD 1 TO HEX                                                   761
                     .                                                                          762
032A  E0F1                    LDR    R,CADD,CF1          PUT ADDRESS IN REGISTER                763
032B  ED00 02E2               BAL    I,RET,AHEX          CONVERT VALUE                          764
032D  E02F                    LDR    R,CF1,CA1           PUT HEX VALUE IN FIELD                 765
                     .                                                                          766
                     .                                                                          767
032E  2009                    CMP    IS,CF2,0            SEE IF FIELD 2 IS PRESENT              768
032F  C102 0335               BRCL   EQ,C8               GO PROCESS COMMAND                     769
                     .                                                                          770
                     . CONVERT FIELD 2 TO HEX                                                   771
                     .                                                                          772
0331  E091                    LDR    R,CADD,CF2          PUT ADDRESS IN REGISTER                773
0332  ED00 02E2               BAL    I,RET,AHEX          CONVERT VALUE                          774
0334  E029                    LDR    R,CF2,CA1           PUT HEX VALUE IN FIELD                 775
                     .                                                                          776
                     .                                                                          777
                     . BRANCH TO PROCESS ON COMMAND                                             778
                     .                                                                          779
0335  5EAC           C8       LDR    RX,CV1,CZERO,CMD    GET FIRST CHARACTER OF COMMAND         780
0336  601E                    ADD    IS,CMD,1            INCREMENT ADDRESS                      781
0337  5EAD                    LDR    RX,CV2,CZERO,CMD    GET SECOND CHARACTER OF COMMAND        782
0338  A10D 00FF               AND    I,CV2,000FF         CLEAR UPPER BITS                       783
033A  AE7C                    SHS    LL,CV1,8            LEFT JUSTIFY 1ST CHARACTER             784
033B  80DC                    ADD    R,CV1,CV2           PUT 1ST 2 CHARACTERS IN ONE WORD       785
                     .                                                                          786
033C  B10C 646F               CMP    I,CV1,0646F         COMPARE WITH 'DO'                      787
033E  C102 0352               BRCL   EQ,C9               GO PROCESS DONE                        788
                     .                                                                          789
0340  B10C 6475               CMP    I,CV1,06475         COMPARE WITH 'DU'                      790
0342  C102 0356               BRCL   EQ,C10              GO PROCESS DUMP                        791
                     .                                                                          792
0344  B10C 6469               CMP    I,CV1,06469         COMPARE WITH 'DI'                      793
0346  C102 0383               BRCL   EQ,C11              GO PROCESS DISPLAY                     794
                     .                                                                          795
0348  B10C 6368               CMP    I,CV1,06368         COMPARE WITH 'CH'                      796
```

```
LOC   OBJECT CODE    CARD IMAGE                                                              CARDNUM
034A  C102 039C              BRCL  EQ,C12                GO PROCESS 'CHANGE'                     797
                   .                                                                            798
034C  B10C 6373              CMP   I,CV1,06373           COMPARE WITH 'CS'                       799
034E  C102 03A0              BRCL  EQ,C20                GO PROCESS CHANGE SEQUENTIAL            800
                   .                                                                            801
0350  C107 02FD              BRCL  U,C1                  INVALID COMMAND, GO TRY AGAIN           802
                   .                                                                            803
                   .                                                                            804
                   .                                                                            805
                   .                                                                            806
                   . ****                                                                       807
                   . DONE                                                                       808
                   . ****                                                                       809
                   .                                                                            810
0352  E200 03D3    C9        LDR   D,0,CSAVE             GET ADDRESS OF CALLING ROUTINE          811
0354  C107 0151              BRC   I,7,KEYMR             EXIT THROUGH KEYMR                      812
                   .                                                                            813
                   .                                                                            814
                   .                                                                            815
                   .                                                                            816
                   . ****                                                                       817
                   . DUMP                                                                       818
                   . ****                                                                       819
                   .                                                                            820
0356  A10F FFF8    C10       AND   I,CF1,0FFF8           CLEAR LAST THREE BITS                   821
0358  E0F5                   LDR   R,CV3,CF1             SET UP ADDRESS TO DUMP                  822
0359  40A7                   LDR   IS,CINDX,10           SET UP LINE COUNTER                     823
                   .                                                                            824
                   . OUTPUT LINE OF CORE WITH ADDRESS OF FIRST VALUE                            825
                   .                                                                            826
035A  E10C 03D5    C13       LDR   I,CV1,CBUFF           SET UP OUTPUT BUFFER ADDRESS            827
035C  E0AD                   LDR   R,CV2,CZERO           SET UP ROW COUNTER                      828
035D  E051                   LDR   R,CADD,CV3            SET UP INPUT FOR HEXA                   829
035E  ED00 02BB              BAL   I,RET,HEXA            CONVERT ADDRESS TO ASCII                830
0360  1AC2                   STR   RX,CA1,CV1,CZERO      PUT MSD OF ADD IN OUTPUT BUFFER         831
0361  601C                   ADD   IS,CV1,1              INCREMENT BUFFER ADDRESS                832
0362  1AC3                   STR   RX,CA2,CV1,CZERO      PUT LSD OF ADD IN OUTPUT BUFFER         833
0363  601C                   ADD   IS,CV1,1              INCREMENT BUFFER ADDRESS                834
0364  1ACB                   STR   RX,CSPACE,CV1,CZERO     PUT IN SPACES                         835
0365  601C         C14       ADD   IS,CV1,1              INCREMENT BUFFER ADDRESS                836
0366  1ACB                   STR   RX,CSPACE,CV1,CZERO     PUT IN SPACES                         837
0367  601C                   ADD   IS,CV1,1              INCREMENT BUFFER ADDRESS                838
0368  5A51                   LDR   RX,CADD,CV3,CZERO     GET VALUE TO CONVERT                    839
0369  6015                   ADD   IS,CV3,1              INCREMENT ADD OF VALUE TO OUTPUT        840
036A  ED00 02BB              BAL   I,RET,HEXA            CONVERT VALUE                           841
036C  1AC2                   STR   RX,CA1,CV1,CZERO      PUT MSD OF VALUE IN OUTPUT BUFFER       842
036D  601C                   ADD   IS,CV1,1              INCREMENT BUFFER ADDRESS                843
036E  1AC3                   STR   RX,CA2,CV1,CZERO      PUT LSD OF VALUE IN OUTPUT BUFFER       844
036F  601D                   ADD   IS,CV2,1              INCREMENT ROW COUNTER                   845
0370  208D                   CMP   IS,CV2,8              COMPARE WITH LAST VALUE                 846
0371  C102 0375              BRCL  EQ,C15                BRANCH IF EQUAL                         847
0373  C107 0365              BRCL  U,C14                 GO DO ANOTHER VALUE                     848
0375  E101 03D5    C15       LDR   I,CADD,CBUFF          GET BUFFER POINTER                      849
```

```
LOC   OBJECT CODE      CARD IMAGE                                                                            CARDNUM

0377  6FF1                       ADD   IS,CADD,-1          DECREMENT BY ONE TO GET COUNT                       850
0378  9CF0 03F1                  STRM  D,0,CS1,16          SAVE REGISTERS                                      851
037A  ED00 0230                  BAL   I,RET,OUTPUT        OUTPUT ONE LINE                                     852
037C  BCF0 03F1                  LDRM  D,0,CS1,16          RESTORE REGISTERS                                   853
037E  6FF7                       ADD   IS,CINDX,-1         DECREMENT LINE COUNTER                              854
037F  C105 035A                  BRCL  NZ,C13              DO ANOTHER LINE                                     855
0381  C107 02FD                  BRC   I,7,C1              WAIT FOR ANOTHER COMMAND                            856
                    .                                                                                          857
                    .                                                                                          858
                    .                                                                                          859
                    .                                                                                          860
                    . *******                                                                                  861
                    . DISPLAY                                                                                  862
                    . *******                                                                                  863
                    .                                                                                          864
0383  E0F1          C11          LDR   R,CADD,CP1          GET ADD OF LOCATION TO DISPLAY                      865
0384  ED00 02BB                  BAL   I,RET,HEXA          CONVERT CORE CONTENTS TO ASCII                      866
0386  9C02 040A                  STR   D,CA1,CBUD1         PUT MSD IN OUTPUT BUFFER                            867
0388  9C03 040B                  STR   D,CA2,CBUD1+1       PUT LSD IN OUTPUT BUFFER                            868
038A  E3F1 0000                  LDR   DX,CADD,0,CF1       PUT CORE VALUE IN REGISTER                          869
038C  ED00 02BB                  BAL   I,RET,HEXA          CONVERT ADDRESS TO ASCII                            870
038E  9C02 040D                  STR   D,CA1,CBUD2         PUT MSD IN OUTPUT BUFFER                            871
0390  9C03 040E                  STR   D,CA2,CBUD2+1       PUT LSD IN OUTPUT BUFFER                            872
0392  E101 0409                  LDR   I,CADD,CBUD         PUT ADDRESS IN REGISTER                             873
0394  ED00 0230                  BAL   I,RET,OUTPUT        OUTPUT BUFFER TO CRT                                874
0396  E20F 0412                  LDR   D,CF1,CSFLG         GET FLAG FOR SEQUENTIAL CHANGE                      875
0398  C105 03C5                  BRCL  NZ,C23              GO BACK TO SEQUENTIAL IF FLAG SET                   876
039A  C107 02FD                  BRC   I,7,C1              GO AGAIN                                            877
                    .                                                                                          878
                    .                                                                                          879
                    .                                                                                          880
                    .                                                                                          881
                    . ******                                                                                   882
                    . CHANGE                                                                                   883
                    . ******                                                                                   884
                    .                                                                                          885
039C  9BF9 0000     C12          STR   DX,CF2,0,CP1        CHANGE CORE CONTENTS                                886
039E  C107 0383                  BRC   I,7,C11             GO DISPLAY CORE CHANGE                              887
                    .                                                                                          888
                    .                                                                                          889
                    .                                                                                          890
                                 PAGE                                                                          891
```

```
LOC   OBJECT CODE     CARD IMAGE                                                              CARDNUM
                      .                                                                           892
                      . ************************                                                  893
                      . CHANGE CORE SEQUENTIALLY                                                  894
                      . ************************                                                  895
                      .                                                                           896
03A0  9C0F 0410       C20      STR   D,CF1,CSTRT           SAVE START OF CORE CHANGE              897
03A2  9C0F 0411                STR   D,CF1,CSTOR           SAVE ADDRESS AT WHICH TO STORE         898
03A4  401C                     LDR   IS,CV1,1              SET UP A CONSTANT 1                    899
03A5  9C0C 0412                STR   D,CV1,CSFLG           SET FLAG FOR SEQUENTIAL CHANGE         900
03A7  ED00 0151       C21      BAL   I,RET,KEYMR           GET VALUE FOR CORE                     901
03A9  400A                     LDR   IS,CZERO,0            SET UP ZERO REGISTER                   902
03AA  6011                     ADD   IS,CADD,1             INCREMENT BUFFER POINTER               903
03AB  4015                     LDR   IS,CV3,1              SET UP A CONSTANT 1                    904
03AC  51AC                     LDR   RX,CV1,CZERO,CADD     GET FIRST CHARACTER ENTERED            905
03AD  515D                     LDR   RX,CV2,CV3,CADD       GET SECOND CHARACTER ENTERED           906
03AE  AE7C                     SHS   LL,CV1,8              LEFT JUSTIFY FIRST CHARACTER           907
03AF  AE7D                     SHS   LL,CV2,8              CLEAR UPPER 8 BITS OF SECOND CHAR      908
03B0  AD7D                     SHS   RL,CV2,8              RIGHT JUSTIFY SECOND CHARACTER         909
03B1  80DC                     ADD   R,CV1,CV2             COMBINE BOTH CHARACTERS                910
03B2  B10C 646F                CMP   I,CV1,0646F           COMPARE WITH 'DO'                      911
03E4  C102 03C1                BRCL  EQ,C22                GET OUT IF DONE                        912
03B6  ED00 02E2                BAL   I,RET,AHEX            CONVERT ENTRY TO HEX                   913
03E8  E20F 0411                LDR   D,CF1,CSTOR           GET ADDRESS FOR STORING                914
03BA  9BF2 0000                STR   DX,CA1,0,CF1          PUT VALUE IN CORE                      915
03BC  601F                     ADD   IS,CF1,1              INCREMENT STORE ADDRESS                916
03BD  9C0F 0411                STR   D,CF1,CSTOR           SAVE NEW STORE ADDRESS                 917
03BF  C107 03A7                BRCL  U,C21                 GO GET ANOTHER ENTRY                   918
03C1  E20F 0410       C22      LDR   D,CF1,CSTRT           GET ADDRESS OF FIRST CORE CHANGED      919
03C3  C107 0383                BRCL  U,C11                 GO DISPLAY LOCATION                    920
03C5  E20C 0410       C23      LDR   D,CV1,CSTRT           GET ADDRESS DISPLAYED                  921
03C7  601C                     ADD   IS,CV1,1              INCREMENT ADDRESS                      922
03C8  9C0C 0410                STR   D,CV1,CSTRT           SAVE AS NEW DISPLAY ADDRESS            923
03CA  B20C 0411                CMP   D,CV1,CSTOR           COMPARE WITH LAST ADDRESS+1            924
03CC  C104 03C1                BRCL  LT,C22                DO AGAIN IF NOT FINISHED               925
03CE  400C                     LDR   IS,CV1,0              GET A ZERO                             926
03CF  9C0C 0412                STR   D,CV1,CSFLG           CLEAR SEQUENTIAL FLAG                  927
03D1  C107 02FD                BRCL  U,C1                  GO GET ANOTHER COMMAND                 928
                      .                                                                           929
                      .                                                                           930
                      .                                                                           931
                      .                                                                           932
                      . ****************                                                          933
                      . DATA AND BUFFERS                                                          934
                      . ****************                                                          935
                      .                                                                           936
03D3                  CSAVE    DS    1                     ADDRESS OF ROUTINE CALLING CORE        937
                      .                                                                           938
                      .                                                                           939
03D4  001C            CBCNT    DC    28                    COUNT OF VALUES IN BUFFER TO OUTPUT    940
03D5                  CBUFF    DS    27                    OUTPUT BUFFER                          941
03F0  0D0A                     DC    000DA                 CR/LF                                  942
                      .                                                                           943
                      .                                                                           944
```

```
LOC   OBJECT CODE     CARD IMAGE                                                            CARDNUM

03F1                  CS1       DS     20          REG SAVE AREA FOR INTERNAL USE               945
                      .                                                                         946
                      .                                                                         947
0405  0003            CTITLE    DC     3           COUNT                                        948
0406  0D0A                      DC     00D0A       CR/LF                                        949
0407  434F                      DC     0434F       CO                                           950
0408  5245                      DC     05245       RE                                           951
                      .                                                                         952
0409  0006            CBUD      DC     6           COUNT                                        953
040A                  CBUD1     DS     2           2 LOCATIONS FOR ADDRESS                      954
                      .                                                                         955
040C  2020                      DC     02020       BLANKS                                       956
040D                  CBUD2     DS     2           2 LOCATIONS FOR CONTENTS                     957
040F  0D0A                      DC     00D0A       CR/LF                                        958
                      .                                                                         959
0410  0000            CSTRT     DC     0           START ADDRESS FOR SEQUENTIAL CORE            960
0411  0000            CSTOR     DC     0           CURRENT ADDRESS FOR STORING IN SEQ           961
0412  0000            CSFLG     DC     0           FLAG FOR SEQUENTIAL CHANGE                   962
                      .                                                                         963
                      .                                                                         964
                      .                                                                         965
                                END                                                             966
```

```
LOC    OBJECT CODE      CARD IMAGE

0000                             IDT    ATAC
                                 DS     0500
                                 ENTRY  WJ
                        .
                        RET      EQU    0
                        OUTPUT   EQU    00230
                        KEYMR    EQU    00151
                        .
                        .
                        . ****************
                        . ESTABLISH EQUATES
                        . ****************
                        .
                        WJXS     EQU    1                     XAR START
                        WJXE     EQU    2                     XAR END
                        WJX1     EQU    3                     XAR 1
                        WJX2     EQU    4                     XAR 2
                        WJX3     EQU    5                     XAR 3
                        WJX4     EQU    6                     XAR 4
                        WJD1     EQU    7                     DATA 1
                        WJD2     EQU    8                     DATA 2
                        WJD3     EQU    9                     DATA 3
                        WJD4     EQU    10                    DATA 4
                        WJXX     EQU    11                    XAR FOR CHECK
                        WJV1     EQU    1                     VARIABLE 1
                        WJV2     EQU    2                     VARIABLE 2
                        WJV3     EQU    3                     VARIABLE 3
                        WJV4     EQU    4                     VARIABLE 4
                        WJV5     EQU    5                     VARIABLE 5
                        WJV6     EQU    6                     VARIABLE 6
                        WJV7     EQU    7                     VARIABLE 7
                        WJV8     EQU    8                     VARIABLE 8
                        WJV9     EQU    9                     VARIABLE 9
                        WJV10    EQU    10                    VARIABLE 10
                        WJV11    EQU    11                    VARIABLE 11
                        WJLPC    EQU    15                    WJS COUNTER
                        .
                        .
                        .
                        .
                        . *****
                        . ENTRY
                        . *****
                        .
0500   9C00 09AD        WJ       STR    D,RET,WJRET           SAVE RETURN ADDRESS
                        .
                        . ******************
                        . INITIALIZE RECEIVER
                        . ******************
                        .
0502   BC31 09BC        WJ01     LDRM   D,WJV1,WJI1,4         GET INITIAL CONTROL WORDS FOR RCVR
0504   9C31 09C8                 STRM   D,WJV1,WJCW1,4        PUT INITIAL VALUES INTO CONTROL
0506   BC71 09C0                 LDRM   D,WJV1,WJICD,8        GET INITIAL CONTROL WORD DISPLAY
0508   9C71 09D8                 STRM   D,WJV1,WJCFL,8        SAVE INITIAL CONTROL WORD DISPLAY
```

```
LOC    CBJECT CODE     CARD IMAGE

050A   E603 09BB               LLC    D,WJX1,WJCRO          LOAD "ADDRESS ON"
050C   D932                    ROUT   02,WJX1               ENABLE RECEIVER/TURN ON INTERFACE
050D   E101 0000               LDR    I,WJXS,0              CLEAR REGISTER
050F   9C01 09F4               STR    D,WJXS,CHKFLG1        CLEAR FLAG
0511   9C01 09F6               STR    D,WJXS,WJLPK          ZERO WJS COUNTER
0513   ED00 08AE               BAL    I,RET,WJS             SEND INITIAL CONTROL WORD TO RCVR
0515   E101 0A02               LDR    I,WJV1,WJINS          GET ADDRESS OF INSTRUCTION BUFFER
0517   ED00 0230               BAL    I,RET,OUTPUT          OUTPUT INSTRUCTIONS TO CRT
0519   E101 09F7       WJ02    LDR    I,WJV1,WJT            GET ADDRESS OF TITLE BUFFER
051B   ED00 07AE               BAL    I,RET,WJ90            OUTPUT TITLE AND GET ENTRY
051D   C107 0519               BRCL   U,WJ02                ILLEGAL ENTRY
                       .
                       .  *****************
                       .  TRANSLATE COMMAND
                       .  *****************
                       .
051F   2012                    CMP    IS,WJV2,1             COMPARE WITH ONE
0520   C105 0519               BRCL   NE,WJ02               WILL ONLY ACCEPT ONE CHAR
0522   2083                    CMP    IS,WJV3,8             COMPARE WITH MAX VALUE
0523   C101 0519               BRCL   GT,WJ02               ENTRY OUT OF RANGE
                       .
                       .  ***************************
                       .  BRANCH ACCORDING TO COMMAND
                       .****************************
                       .
0525   E330 0528               LDR    DX,RET,WJBRC,WJV3     GET ADDRESS FOR BRANCH FROM TABLE
0527   BF07                    BRC    R,7,RET               GO PROCESS ACCORDING TO COMMAND
                       .
                       .  BRANCH TABLE FOR COMMANDS FROM OPERATOR
                       .
0528   0531            WJBRC   DC     WJ10                  0=SET UP TENTATIVE WORD
0529   05AE                    DC     WJ20                  1=DISPLAY TENTATIVE CONTROL WORD
052A   05C6                    DC     WJ30                  2=DISPLAY CONTROL WORD
052B   05DE                    DC     WJ40                  3=DISPLAY LAST RECEIVED WORD
052C   0614                    DC     WJ50                  4=ENTER TENTATIVE WORD AS NEW CONTRO
052D   0657                    DC     WJ60                  5=SCAN
052E   C790                    DC     WJ70                  6=RECEIVE CONTROL WORD FROM RCVR
052F   C7A8                    DC     WJ80                  7=DONE
0530   C502                    DC     WJ01                  8=REINITIALIZE
                       .
                       .
                       .
                       .
                       .  *****************
                       .  SET UP (COMMAND=0)
                       .  *****************
                       .
                       .  OUTPUT TITLE AND GET KEYBOARD ENTRY FOR FREQUENCY
                       .
0531   E101 0A4B       WJ10    LDR    I,WJV1,WJFB           GET ADDRESS OF FREQUENCY TITLE
0533   ED00 07AE               BAL    I,RET,WJ90            OUTPUT TITLE AND GET ENTRY
0535   C107 0531               BRCL   U,WJ10                ILLEGAL ENTRY
0537   ED00 07CC               BAL    I,RET,WJ91            MAKE SURE FREQUENCY IS LEGAL
```

```
LOC   OBJECT CODE     CARD IMAGE                                                               CARDNUM

0539  C107 0531                 BRCL  U,WJ10             ILLEGAL FREQUENCY
053B  9C03 09D0                 STR   D,WJV3,WJTFL       STORE TENTATIVE FREQUENCY (LOWER)
053D  9C04 09D1                 STR   D,WJV4,WJTFU       STORE TENTATIVE FREQUENCY (UPPER)
                     .
                     . OUTPUT TITLE AND GET KEYBOARD ENTRY FOR DETECT MODE
                     .
053F  E101 0A89      WJ11       LDR   I,WJV1,WJDMB       GET ADDRESS OF DETECT MODE TITLE
0541  ED00 07AE                 BAL   I,RET,WJ90         OUTPUT TITLE AND GET ENTRY
0543  C107 053F                 BRCL  U,WJ11             ILLEGAL ENTRY
0545  2073                      CMP   IS,WJV3,7          COMPARE WITH MAX VALUE
0546  C101 053F                 BRCL  GT,WJ11            TOO LARGE
0548  9C03 09D2                 STR   D,WJV3,WJTDM       SAVE TENTATIVE DETECT MODE
054A  E101 0004                 LDR   I,WJV1,04          GET UPPER OF DEFAULT BFO FREQUENCY
054C  9C01 09D4                 STR   D,WJV1,WJTBU       SAVE TENTATIVE BFO FREQUENCY (UPPER)
054E  E101 5500                 LDR   I,WJV1,05500       GET LOWER OF DEFAULT BFO FREQUENCY
0550  9C01 09D3                 STR   D,WJV1,WJTBL       SAVE TENTATIVE BFO FREQUENCY (LOWER)
0552  2033                      CMP   IS,WJV3,3          COMPARE DETECT MODE WITH BFO VARIABL
0553  C105 056E                 BRCL  NE,WJ13            NOT VARIABLE BFO, USE DEFAULT FREQUE
                     .
                     . OUTPUT TITLE AND GET KEYBOARD ENTRY FOR BFO FREQUENCY
                     .
0555  E101 0AB3      WJ12       LDR   I,WJV1,WJBFB       GET ADDRESS OF BFO FREQUENCY TITLE
0557  ED00 07AE                 BAL   I,RET,WJ90         OUTPUT TITLE AND GET ENTRY
0559  C107 0555                 BRCL  U,WJ12             ILLEGAL ENTRY
055B  2062                      CMP   IS,WJV2,6          COMPARE WITH EXACT COUNT
055C  C105 0555                 BRCL  NE,WJ12            WRONG COUNT
055E  E833                      SHD   RL,WJV3,4          POSITION FREQUENCY (10 HZ RES)
055F  2044                      CMP   IS,WJV4,04         COMPARE UPPER WITH EXACT VALUE
0560  C105 0555                 BRCL  NE,WJ12            ILLEGAL ENTRY
0562  B103 4500                 CMP   I,WJV3,04500       COMPARE LOWER WITH MIN VALUE
0564  C104 0555                 BRCL  LT,WJ12            ILLEGAL ENTRY
0566  B103 6500                 CMP   I,WJV3,06500       COMPARE LOWER WITH MAX VALUE
0568  C101 0555                 BRCL  GT,WJ12            ILLEGAL ENTRY
056A  9C03 09D3                 STR   D,WJV3,WJTBL       SAVE TENTATIVE BFO FREQUENCY (LOWER)
C56C  9C04 09D4                 STR   D,WJV4,WJTBU       SAVE TENTATIVE BFO FREQUENCY (UPPER)
                     .
                     . OUTPUT TITLE AND GET KEYBOARD ENTRY FOR GAIN MODE
                     .
056E  E101 0A53      WJ13       LDR   I,WJV1,WJGMB       GET ADDRESS OF GAIN MODE TITLE
0570  ED00 07AE                 BAL   I,RET,WJ90         OUTPUT TITLE AND GET ENTRY
0572  C107 056E                 BRCL  U,WJ13             ILLEGAL ENTRY
0574  2033                      CMP   IS,WJV3,3          COMPARE WITH MAX VALUE
0575  C101 056E                 BRCL  GT,WJ13            ILLEGAL ENTRY
0577  2013                      CMP   IS,WJV3,1          COMPARE WITH ENTRY FO 1
0578  C102 056E                 BRCL  EQ,WJ13            ILLEGAL ENTRY
057A  E201 09D2                 LDR   D,WJV1,WJTDM       GET TENTATIVE DETECT MODE
057C  2041                      CMP   IS,WJV1,4          COMPARE WITH ISB
057D  C105 0582                 BRCL  NE,WJ131           BRANCH IF NOT ISB
057F  2003                      CMP   IS,WJV3,0          MAKE SURE GAIN MODE NOT HOLD AGC
0580  C102 056E                 BRCL  EQ,WJ13            ILLEGAL ENTRY
C582  9C03 09D5      WJ131      STR   D,WJV3,WJTGM       SAVE TENTATIVE GAIN MODE
                     .
                     . OUTPUT TITLE AND GET KEYBOARD ENTRY FOR IF BANDWIDTH
```

```
LOC    OBJFCT CODE      CARD IMAGE                                                          CARDNUM

                     .
0584   E201 09D2               LDR    D,WJV1,WJTDM         GET TENTATIVE DETECT MODE
0586   2041                    CMP    IS,WJV1,4            COMPARE WITH ISE
0587   C104 058F               BRCL   LT,WJ14              NOT SIDEBAND-BRANCH
0589   2061                    CMP    IS,WJV1,6            COMPARE WITH USE
058A   C101 058F               BRCL   GT,WJ14              NOT SIDEBAND-BRANCH
058C   4043                    LDR    IS,WJV3,4            LOAD DEFAULT IF BANDWIDTH
058D   C107 059B               BRCL   U,WJ141              SKIP IF BANDWIDTH
058F   E101 0A6D     WJ14      LDR    I,WJV1,WJIFB         GET ADDRESS OF IF BANDWIDTH TITLE
0591   ED00 07AE               BAL    I,RET,WJ90           OUTPUT TITLE AND GET ENTRY
0593   C107 058F               BRCL   U,WJ14               ILLEGAL ENTRY
0595   2043                    CMP    IS,WJV3,4            COMPARE WITH MAX VALUE
0596   C101 058F               BRCL   GT,WJ14              ILLEGAL ENTRY
0598   2013                    CMP    IS,WJV3,1            COMPARE WITH MIN VALUE
0599   C104 058F               BRCL   LT,WJ14              ILLEGAL ENTRY
059B   9C03 09D7     WJ141     STR    D,WJV3,WJTIF         SAVE TENTATIVE IF BANDWIDTH
                     .
                     . OUTPUT TITLE AND GET KEYBOARD ENTRY FOR RF GAIN
                     .
059D   E101 0ACA     WJ15      LDR    I,WJV1,WJRFGB        GET ADDRESS OF RF GAIN TITLE
059F   ED00 07AE               BAL    I,RET,WJ90           OUTPUT TITLE AND GET ENTRY
05A1   C107 059D               BRCL   U,WJ15               ILLEGAL ENTRY
05A3   2032                    CMP    IS,WJV2,3            COMPARE WITH MAX COUNT
05A4   C101 059D               BRCL   GT,WJ15              ILLEGAL ENTRY
05A6   B103 0100               CMP    I,WJV3,0100          COMPARE WITH MAX VALUE
05A8   C101 059D               BRCL   GT,WJ15              ILLEGAL ENTRY
05AA   9C03 09D6               STR    D,WJV3,WJTRFG        SAVE TENTATIVE RF GAIN
                     .
05AC   C107 0519               BRCL   U,WJ02               GO GET ANOTHER COMMAND
                     .
                     .
                     .
                     .
                     . ******************************************
                     . DISPLAY TENTATIVE CONTROL WORD (COMMAND=1)
                     . ******************************************
                     .
05AE   E202 09D1     WJ20      LDR    D,WJV2,WJTFU         GET UPPER OF TENTATIVE FREQUENCY
05B0   E201 09D0               LDR    D,WJV1,WJTFL         GET LOWER OF TENTATIVE FREQUENCY
05B2   ED00 07D9               BAL    I,RET,WJ92           PUT FREQUENCY IN BUFFER AND DISPLAY
05B4   E201 09D5               LDR    D,WJV1,WJTGM         GET TENTATIVE GAIN MODE
05B6   E202 09D7               LDR    D,WJV2,WJTIF         GET TENTATIVE IF BANDWIDTH
05B8   ED00 0801               BAL    I,RET,WJ93           OUTPUT GAIN MODE AND IF BANDWIDTH
05BA   E201 09D2               LDR    D,WJV1,WJTDM         GET TENTATIVE DETECT MODE
05BC   E202 09D3               LDR    D,WJV2,WJTBL         GET TENTATIVE BFO FREQUENCY (LOWER)
05BE   ED00 0820               BAL    I,RET,WJ94           OUTPUT DETECT MODE AND BFO FREQUENCY
05C0   E201 09D6               LDR    D,WJV1,WJTRFG        GET TENTATIVE RF GAIN
05C2   ED00 084A               BAL    I,RET,WJ95           OUTPUT RF GAIN
05C4   C107 0519               BRCL   U,WJ02               DONE
                     .
                     .
                     .
                     .
```

```
LOC    OBJECT CODE     CARD IMAGE                                                                    CARDNUM
                     . ********************************
                     . DISPLAY CONTROL WORD (COMMAND=2)
                     . ********************************
                     .
05C6   E202 09D9     WJ30      LDR    D,WJV2,WJCFU        GET UPPER OF CONTROL FREQUENCY
05C8   E201 09D8               LDR    D,WJV1,WJCFL        GET LOWER OF CONTROL FREQUENCY
05CA   ED00 07D9               BAL    I,RET,WJ92          OUTPUT FREQUENCY
05CC   E201 09DD               LDR    D,WJV1,WJCGM        GET CONTROL GAIN MODE
05CE   E202 09DF               LDR    D,WJV2,WJCIF        GET CONTROL IF BANDWIDTH
05D0   ED00 0801               BAL    I,RET,WJ93          OUTPUT GAIN MODE AND IF BANDWIDTH
05D2   E201 09DA               LDR    D,WJV1,WJCDM        GET CONTROL DETECT MODE
05D4   E202 09DB               LDR    D,WJV2,WJCBL        GET CONTROL BFO FREQUENCY (LOWER)
05D6   ED00 0820               BAL    I,RET,WJ94          OUTPUT DETECT MODE AND BFO FREQUENCY
05D8   E201 09DE               LDR    D,WJV1,WJCRFG       GET CONTROL RF GAIN
05DA   ED00 084A               BAL    I,RET,WJ95          OUTPUT RF GAIN
05DC   C107 0519               BRCL   U,WJ02              DONE
                     .
                     .
                     .
                     .
                     . ********************************
                     . DISPLAY RECEIVED WORD (COMMAND=3)
                     . ********************************
                     .
05DE   E202 09E1     WJ40      LDR    D,WJV2,WJRFU        GET UPPER OF RECEIVED FREQUENCY
05E0   E201 09E0               LDR    D,WJV1,WJRFL        GET LOWER OF RECEIVED FREQUENCY
05E2   ED00 07D9               BAL    I,RET,WJ92          OUTPUT FREQUENCY
05E4   E201 09E5               LDR    D,WJV1,WJRGM        GET RECEIVED GAIN MODE
05E6   E202 09E7               LDR    D,WJV2,WJRIF        GET RECEIVED IF BANDWIDTH
05E8   ED00 0801               BAL    I,RET,WJ93          OUTPUT GAIN MODE AND IF BANDWIDTH
05EA   E201 09E2               LDR    D,WJV1,WJRDM        GET RECEIVED DETECT MODE
05EC   E202 09E3               LDR    D,WJV2,WJRBL        GET RECEIVED BFO FREQUENCY (LOWER)
05EE   ED00 0820               BAL    I,RET,WJ94          OUTPUT DETECT MODE AND BFO FREQUENCY
05F0   E201 09E6               LDR    D,WJV1,WJRRFG       GET RECEIVED RF GAIN
05F2   ED00 084A               BAL    I,RET,WJ95          OUTPUT RF GAIN
05F4   E201 09E9               LDR    D,WJV1,WJRSS        GET RECEIVED SIGNAL STRENGTH
05F6   4002                    LDR    IS,WJV2,0           CLEAR REGISTER
05F7   F871                    SHD    LL,WJV1,8           POSITION 1ST DIGIT
05F8   A502 2030               IOR    I,WJV2,02030        CONVERT TO ASCII
05FA   9C02 0B22               STR    D,WJV2,WJDSS1       STORE IN OUTPUT BUFFER
05FC   4002                    LDR    IS,WJV2,0           CLEAR REGISTER
05FD   F831                    SHD    LL,WJV1,4           POSITION LAST 2 DIGITS
05FE   AE32                    SHS    LL,WJV2,4
05FF   F831                    SHD    LL,WJV1,4
0600   A502 3030               IOR    I,WJV2,03030        CONVERT TO ASCII
0602   9C02 0B23               STR    D,WJV2,WJDSS1+1     STORE IN OUTPUT BUFFER
0604   E101 0B18               LDR    I,WJV1,WJDSS        GET ADDRESS OF BUFFER TO OUTPUT
0606   ED00 0230               BAL    I,RET,OUTPUT        OUTPUT BUFFER
0608   C107 0519               BRCL   U,WJ02              DONE
060A                           DS     10                  SPACE FOR PATCHES
                     .
                     .
                     .
```

```
LOC   OBJECT CODE    CARD IMAGE                                                                CARDNUM

                     .
                     . ****************************************
                     . ENTER TENTATIVE CONTROL WORD (COMMAND=4)
                     . ****************************************
                     .
0614  BC71 09D0      WJ50     LDRM   D,WJV1,WJTFL,8      GET TENTATIVE VALUES IN DISPLAY FORM
0616  9C71 09D8               STRM   D,WJV1,WJCFL,8      STORE IN CONTROL VALUES IN DISPLAY F
0618  F831                    SHD    LL,WJV1,4           POSITION FREQUENCY
0619  9C02 09C8               STR    D,WJV2,WJCW1        SET UP CONTROL WORD 1
061B  AE16                    SHS    LL,WJV6,2           POSITION GAIN MODE
061C  A461                    IOR    R,WJV1,WJV6         PUT IN CW 2
061D  E082                    LDR    R,WJV2,WJV8         GET IF BANDWIDTH
061E  AD02                    SHS    RL,WJV2,1           POSITION BANDWIDTH
061F  A421                    IOR    R,WJV1,WJV2         PUT IN CW 2
0620  9C01 09C9               STR    D,WJV1,WJCW2        STORE CONTROL WORD 2
0622  E081                    LDR    R,WJV1,WJV8         GET IF BANDWIDTH
0623  AEE1                    SHS    LL,WJV1,15          POSITION LAST DIGIT OF BANDWIDTH
0624  AEB3                    SHS    LL,WJV3,12          POSITION DETECT MODE
0625  A431                    IOR    R,WJV1,WJV3         PUT DETECT MODE IN CW 3
0626  9C01 09CA               STR    D,WJV1,WJCW3        SAVE CW 3
0628  E042                    LDR    R,WJV2,WJV4         GET BFO LOWER VALUE
0629  ED00 098E               BAL    I,RET,WJBCDH        CONVERT BCD VALUE TO HEX
062B  E501 1194               SUB    I,WJV1,4500         SUBTRACT 4500 FROM VALUE
062D  CD01 07FF               MUL    I,WJV1,07FF         MULTIPLY BY 7FF
062F  E103 07D0               LDR    I,WJV3,2000         SET UP DIVISOR
0631  8101 0373               ADD    I,WJV1,0373         ROUND
0633  FC31                    DIV    R,WJV1,WJV3         DIVIDE
0634  E023                    LDR    R,WJV3,WJV2         REARRANGE  REGISTERS
0635  E201 09CA      WJ503    LDR    D,WJV1,WJCW3        GET REST OF CW 3
0637  A431                    IOR    R,WJV1,WJV3         GET BFO FREQUENCY INTO CW 3
0638  9C01 09CA               STR    D,WJV1,WJCW3        STORE CONTROL WORD 3
063A  E202 09D6               LDR    D,WJV2,WJTRFG       GET RF GAIN VALUE
063C  ED00 098E               BAL    I,RET,WJBCDH        CONVERT BCD TO HEX
063E  CD01 007F               MUL    I,WJV1,07F          MULTIPLY BY 7F
0640  6321                    ADD    IS,WJV1,032         ROUND
0641  4643                    LDR    IS,WJV3,064         SET UP DIVISOR
0642  FC31                    DIV    R,WJV1,WJV3         DIVIDE
0643  B421                    LLC    R,WJV1,WJV2         GET VALUE COMPLEMENTED FOR WJ
0644  A101 007F               AND    I,WJV1,07F          CLEAR ALL BUT VALUE WANTED
0646  AE71                    SHS    LL,WJV1,8           POSITION RF GAIN
0647  9C01 09CB               STR    D,WJV1,WJCW4        STORE CONTROL WORD 4
0649  ED00 08AE               BAL    I,RET,WJS           OUTPUT CONTROL WORD TO WJ
064B  C107 0519               BRCL   U,WJ02              DONE
064D                          DS     10                  SPACE FOR PATCHES
                     .
                     .
                     .
                     .
                     . ****************
                     . SCAN (CCMMAND=5)
                     . ****************
                     .
0657  4001           WJ60     LDR    IS,WJV1,0           CLEAR REGISTER
```

```
LOC   OBJECT CODE     CARD IMAGE                                                                              CARDNUM

0658  9C01 09F0              STR   D,WJV1,WJSCNT       INITIALIZE PASS COUNT                                   320
065A  E101 0B97              LDR   I,WJV1,WJSCAN       GET ADDRESS OF SCAN TITLE                               321
065C  ED00 0230              BAL   I,RET,OUTPUT        OUTPUT SCAN TITLE                                       322
065E                         DS    10                  SPACE FOR PATCHES                                       323
                  .                                                                                            324
                  . OUTPUT TITLE AND GET LOWER FREQUENCY LIMIT                                                 325
                  .                                                                                            326
0668  E101 0B9C   WJ601      LDR   I,WJV1,WJSFS        GET ADDRESS OF START FREQUENCY TITLE                    327
066A  ED00 07AE              BAL   I,RET,WJ90          OUTPUT TITLE AND GET ENTRY                              328
066C  C107 0668              BRCL  U,WJ601             ILLEGAL ENTRY                                           329
066E  ED00 07CC              BAL   I,RET,WJ91          MAKE SURE FREQ IS IN LEGAL BOUNDS                       330
0670  C107 0668              BRCL  U,WJ601             ILLEGAL ENTRY                                           331
0672  9C03 09ED              STR   D,WJV3,WJSFLL       SAVE LOWER LIMIT (LOWER)                                332
0674  9C04 09EC              STR   D,WJV4,WJSFLU       SAVE LOWER LIMIT (UPPER)                                333
0676                         DS    10                  SPACE FOR PATCHES                                       334
                  .                                                                                            335
                  . OUTPUT TITLE AND GET UPPER FREQUENCY LIMIT                                                 336
                  .                                                                                            337
0680  E101 0BA7   WJ602      LDR   I,WJV1,WJSFE        GET ADDRESS OF END FREQ TITLE                           338
0682  ED00 C7AE              BAL   I,RET,WJ90          OUTPUT TITLE AND GET ENTRY                              339
0684  C107 0680              BRCL  U,WJ602             ILLEGAL ENTRY                                           340
0686  ED00 07CC              BAL   I,RET,WJ91          MAKE SURE FREQ IS IN LEGAL BOUNDS                       341
0688  C107 0680              BRCL  U,WJ602             ILLEGAL ENTRY                                           342
068A  9C03 09EB              STR   D,WJV3,WJSFUL       SAVE UPPER LIMIT (LOWER)                                343
068C  9C04 09EA              STR   D,WJV4,WJSFUU       SAVE UPPER LIMIT (UPPER)                                344
068E                         DS    10                  SPACE FOR PATCHES                                       345
                  .                                                                                            346
                  . MAKE SURE UPPER LIMIT GREATER THAN LOWER LIMIT                                             347
                  .                                                                                            348
0698  E205 09EC              LDR   D,WJV5,WJSFLU       GET LOWER LIMIT (UPPER)                                 349
069A  B054                   CMP   R,WJV4,WJV5         COMPARE UPPER AND LOWER LIMITS' (UPPE                   350
069B  C104 0668              BRCL  LT,WJ601            UPPER LIMIT LESS THAN LOWER                             351
069D  C101 06AE              BRCL  GT,WJ603            NO NEED TO CHECK FURTHER                                352
069F  E205 09ED              LDR   D,WJV5,WJSFLL       GET LOWER LIMIT (LOWER)                                 353
06A1  B053                   CMP   R,WJV3,WJV5         COMPARE UPPER AND LOWER LIMITS (LOWE                    354
06A2  C106 0668              BRCL  LE,WJ601            LESS OR EQUAL, TRY AGAIN                                355
06A4                         DS    10                  SPACE FOR PATCHES                                       356
                  .                                                                                            357
                  . OUTPUT TITLE AND GET FREQUENCY INCREMENT (8000HZ MAX)                                      358
                  .                                                                                            359
06AE  E101 0BB1   WJ603      LDR   I,WJV1,WJSFI        GET ADDRESS OF FREQ INC TITLE                           360
06E0  ED00 07AE              BAL   I,RET,WJ90          OUTPUT TITLE AND GET ENTRY                              361
06E2  C107 06AE              BRCL  U,WJ603             ILLEGAL ENTRY                                           362
06B4  E833                   SHD   RL,WJV3,4           POSITION INCREMENT                                      363
06B5  2042                   CMP   IS,WJV2,4           COMPARE COUNT WITH MAX                                  364
06E6  C101 06AE              BRCL  GT,WJ603            ILLEGAL - TOO LARGE                                     365
06B8  B103 0800              CMP   I,WJV3,0800         COMPARE WITH MAX INCREMENT                              366
06EA  C101 06AE              BRCL  GT,WJ603            ILLEGAL - TOO LARGE                                     367
06BC  2013                   CMP   IS,WJV3,1           COMPARE WITH MIN INCREMENT                              368
06ED  C104 06AE              BRCL  LT,WJ603            ILLEGAL - TOO SMALL                                     369
06BF  9C03 09EE              STR   D,WJV3,WJSFIN       SAVE INCREMENT                                          370
06C1                         DS    10                  SPACE FOR PATCHES                                       371
                  .                                                                                            372
```

```
LOC   OBJECT CODE     CARD IMAGE                                                             CARDNUM

                      . OUTPUT TITLE AND GET SIGNAL STRENGTH                                     373
                      .                                                                          374
06CB  E101 0BBE       WJ604   LDR   I,WJV1,WJSSS      GET ADDRESS OF SIGNAL STRENGTH TITLE       375
06CD  ED00 07AE               BAL   I,RET,WJ90        OUTPUT TILE AND GET ENTRY                  376
06CF  C107 06CB               BRCL  U,WJ604           ILLEGAL ENTRY                              377
06D1  B103 0100               CMP   I,WJV3,0100       COMPARE WITH MAX VALUE                     378
06D3  C101 06CB               BRCL  GT,WJ604          ILLEGAL - TOO LARGE                        379
06D5  2032                    CMP   IS,WJV2,3         COMPARE COUNT WITH MAX                     380
06D6  C101 06CB               BRCL  GT,WJ604          ILLEGAL - TOO LARGE                        381
06D8  E032                    LDR   R,WJV2,WJV3       PUT SIGNAL STRENGTH IN REG 2               382
06D9  ED00 098E               BAL   I,RET,WJBCDH      CONVERT BCD TO HEX                         383
06DB  CD01 007F               MUL   I,WJV1,07F        MULTIPLY BY 127                            384
06DD  6321                    ADD   IS,WJV1,032       ROUND                                      385
06DE  4643                    LDR   IS,WJV3,064       SET UP DIVISOR                             386
06DF  FC31                    DIV   R,WJV1,WJV3       DIVIDE BY 100                              387
06E0  A102 007F               AND   I,WJV2,07F        CLEAR ALL BUT VALUE WANTED                 388
06E2  9C02 09EF               STR   D,WJV2,WJSFSS     STORE DESIRED SIGNAL STRENGTH              389
06E4                          DS    10                SPACE FOR PATCHES                          390
                      .                                                                          391
                      . OUTPUT FREQUENCY TO RECEIVER AND GET RESPONSE                            392
                      .                                                                          393
06EE  E205 09ED       WJ605   LDR   D,WJV5,WJSFLL     GET LOWER LIMIT (LOWER)                    394
06F0  E206 09EC               LDR   D,WJV6,WJSFLU     GET LOWER LIMIT (UPPER)                    395
06F2  F835            WJ606   SHD   LL,WJV5,4         POSITION FREQUENCY FOR WJ                  396
06F3  E203 09C9               LDR   D,WJV3,WJCW2      GET CONTROL WORD 2 (FREQ LOWER)            397
06F5  E204 09C8               LDR   D,WJV4,WJCW1      GET CONTROL WORD 1 (FREQ UPPER)            398
06F7  A103 000F               AND   I,WJV3,0F         CLEAR OLD FREQ (LOWER)                     399
06F9  A104 0000               AND   I,WJV4,0          CLEAR OLD FREQ (UPPER)                     400
06FB  A453                    IOR   R,WJV3,WJV5       PUT IN NEW FREQ (LOWER)                    401
06FC  A464                    IOR   R,WJV4,WJV6       PUT IN NEW FREQ (UPPER)                    402
06FD  9C03 09C9               STR   D,WJV3,WJCW2      SAVE NEW CONTROL WORD 2                    403
06FF  9C04 09C8               STR   D,WJV4,WJCW1      SAVE NEW CONTROL WORD 1                    404
0701  ED00 08AE               BAL   I,RET,WJS         SEND /RECEIVE NEW CONTROL WORD             405
0703                          DS    10                SPACE FOR PATCHES                          406
                      .                                                                          407
                      . COMPARE RECEIVED SIGNAL STRENGTH WITH SET SIGNAL STRENGTH                408
                      .                                                                          409
070D  E201 09CF               LDR   D,WJV1,WJRS4      GET RECEIVED WORD 4                        410
070F  A101 007F               AND   I,WJV1,07F        CLEAR ALL BUT SIGNAL STRENGTH              411
0711  E202 09EF               LDR   D,WJV2,WJSFSS     GET SPECIFIED SIGNAL STRENGTH              412
0713  B021                    CMP   R,WJV1,WJV2       COMPARE RECEIVED WITH SPECIFIED            413
0714  C103 074E               BRCL  GE,WJ609          FIND                                       414
0716                          DS    10                SPACE FOR PATCHES                          415
                      .                                                                          416
                      . INCREMENT FREQUENCY AND TRY AGAIN                                        417
                      .                                                                          418
0720  E201 09C9               LDR   D,WJV1,WJCW2      GET LAST FREQ (LOWER)                      419
0722  E202 09C8               LDR   D,WJV2,WJCW1      GET LAST FREQ (UPPER)                      420
0724  E831                    SHD   RL,WJV1,4         POSITION FOR INCREMENT                     421
0725  A102 03FF               AND   I,WJV2,03FF       CLEAR ALL BUT FREQUENCY                    422
0727  E203 09EE               LDR   D,WJV3,WJSFIN     GET INCREMENT                              423
0729  4004                    LDR   IS,WJV4,0         CLEAR REGISTER                             424
072A  ED00 0861               BAL   I,RET,WJ96        INCREMENT FREQUENCY                        425
```

```
LOC   OBJECT CODE      CARD IMAGE                                                                       CARDNUM

072C  E201 09EB                LDR    D,WJV1,WJSFUL        GET UPPER LIMIT (LOWER)                         426
072E  E202 09EA                LDR    D,WJV2,WJSFUU        GET UPPER LIMIT (UPPER)                         427
0730  B062                     CMP    R,WJV2,WJV6          COMPARE UPPER LIMIT AND FREQ (UPPER)            428
0731  C101 06F2                BRCL   GT,WJ606             FREQ BELOW LIMIT, KEEP LOOKING                  429
0733  C102 073F                BRCL   EQ,WJ608             UPPER FREQ MATCH,CHECK LOWERS                   430
0735  E201 09F0        WJ607   LDR    D,WJV1,WJSCNT        GET COUNT OF NO. OF TIME THRU                   431
0737  6011                     ADD    IS,WJV1,1            INCREMENT COUNT                                 432
0738  2641                     CMP    IS,WJV1,100          COMPARE WITH MAX TIMES THRU                     433
0739  C101 075E                BRCL   GT,WJ610             DONE - NO FIND                                  434
073B  9C01 09F0                STR    D,WJV1,WJSCNT        SAVE NEW COUNT                                  435
073D  C107 06EE                BRCL   U,WJ605              GO START AT LOWER LIMIT AGAIN                   436
073F  B051             WJ608   CMP    R,WJV1,WJV5          COMPARE LOWERS OF UPPER LIMIT AND FR            437
0740  C104 0735                BRCL   LT,WJ607             LESS, GO START AGAIN                            438
0742  C107 06F2                BRCL   U,WJ606              GO DO WITH NEW FREQUENCY                        439
0744                           DS     10                   SPACE FOR PATCHES                               440
                       .                                                                                 441
                       . FIND                                                                            442
                       .                                                                                 443
C74E  BC11 09E0        WJ609   LDRM   D,WJV1,WJRFL,2       GET RECEIVED FREQUENCY (DISPLAY)                444
0750  9C11 09D8                STRM   D,WJV1,WJCFL,2       STORE IN CONTROL FREQ (DISPLAY)                 445
0752  C107 05DE                BRCL   U,WJ40               GO DISPLAY RECEIVED WORD                        446
0754                           DS     10                   SPACE FOR PATCHES                               447
                       .                                                                                 448
                       . NO FINE - TELL OPERATOR                                                         449
                       .                                                                                 450
075E  BC11 09E0        WJ610   LDRM   D,WJV1,WJRFL,2       GET LAST RECEIVED FREQ (DISPLAY)                451
0760  9C11 09D8                STRM   D,WJV1,WJCFL,2       STORE IN CONTROL FREQ (DISPLAY)                 452
0762  E101 0BCA                LDR    I,WJV1,WJSNF         GET ADDRESS OF NO FIND MESSAGE                  453
0764  ED00 0230                BAL    I,RET,OUTPUT         OUTPUT MESSAGE                                  454
0766  C107 0519                BRCL   U,WJ02               DONE                                            455
0768                           DS     40                   SPACE FOR PATCHES                               456
                       .                                                                                 457
                       .                                                                                 458
                       .                                                                                 459
                       .                                                                                 460
                       . ***********************************************                                461
                       . RECEIVE CONTROL WORD FROM RECEIVER (COMMAND=6)                                  462
                       . ***********************************************                                463
                       .                                                                                 464
0790  E101 0001        WJ70    LDR    I,WJV1,01            LOAD FLAG TO INHIBIT COMPARE                    465
0792  9C01 09F4                STR    D,WJV1,CHKFLG1       STORE FLAG                                      466
0794  ED00 08E1                BAL    I,RET,WJR            INPUT RECEIVER CONTROL WORDS                    467
0796  E101 0000                LDR    I,WJV1,0             ZERO REGISTER                                   468
0798  9C01 09F4                STR    D,WJV1,CHKFLG1       CLEAR FLAG                                      469
079A  C107 05DE                BRCL   U,WJ40               DISPLAY RECEIVED WORDS                          470
079C  C107 0519                BRCL   U,WJ02               RETURN                                          471
079E                           DS     10                   SPACE FOR PATCHES                               472
                       .                                                                                 473
                       .                                                                                 474
                       .                                                                                 475
                       .                                                                                 476
                       . ***************                                                                 477
                       . DONE (COMMAND=7)                                                                478
```

```
LOC   OBJECT CODE     CARD IMAGE                                                                CARDNUM
                    . ***************
                    .
07A8  B601 09B4     WJ80      LLC    D,WJV1,WJCRF          LOAD "ADDRESS OFF"
07AA  D912                    ROUT   02,WJV1               TURN OFF INTERFACE
07AB  E200 09AD               LDR    D,RET,WJRET           LOAD RETURN ADDRESS
07AD  BF07                    BRC    R,7,RET               RETURN TO CALLER
                    .
                    .
                    .
                    .
                    .*************************************************************************
                    . ROUTINE TO OUTPUT BUFFER AND GET ENTRY FROM KEYBCARD
                    . ENTRY: WJV1 ADDRESS OF BUFFER TO BE OUTPUT
                    . EXIT:  WJV2 NUMBER OF CHARACTERS ENTERED
                    .        WJV3 ENTRY (LOWER) BCD
                    .        WJV4 ENTRY (UPPER) BCD
                    . RETUGN FOR ILLEGAL ENTRY
                    . RETURN+2 FOR LEGAL ENTRY
                    .*************************************************************************
                    .
07AE  9C00 09F1     WJ90      STR    D,RET,WJ90R           SAVE THE RETURN ADDRESS
07B0  ED00 0230               BAL    I,RET,OUTPUT          OUTPUT BUFFER
07B2  ED00 0151               BAL    I,RET,KEYMR           GET INPUT FROM KEYBOARD
07B4  4003                    LDR    IS,WJV3,0             CLEAR REGISTER
07B5  4004                    LDR    IS,WJV4,0             CLEAR REGISTER
07B6  4005                    LDR    IS,WJV5,0             CLEAR REGISTER
07B7  5152                    LDR    RX,WJV2,WJV5,WJV1     GET COUNT FROM KEYMR
07B8  E027                    LDR    R,WJV7,WJV2           SET UP INDEX FOR LOOP
07B9  E200 09F1               LDR    D,RET,WJ90R           GET RETURN ADDRESS
07BB  6FF7                    ADD    IS,WJV7,-1            DECREMENT COUNT
07BC  BF04                    BRC    R,4,RET               ILLEGAL IF NEG, NOTHING ENTERED
07BD  6011          WJ901     ADD    IS,WJV1,1             INCREMENT BUFFER POINTER
07BE  5156                    LDR    RX,WJV6,WJV5,WJV1     GET ONE CHARACTER
07BF  2306                    CMP    IS,WJV6,030           COMPARE CHAR WITH ASCII ZERO
07C0  BF04                    BRC    R,4,RET               ILLEGAL CHARACTER IS LESS
07C1  2396                    CMP    IS,WJV6,039           COMPARE WITH ASCII 9
07C2  BF01                    BRC    R,1,RET               ILLEGAL CHARACTER IS GREATER
07C3  A106 000F               AND    I,WJV6,0F             CLEAR UPPER 12 BITS
07C5  F833                    SHD    LL,WJV3,4             POSITION ENTRY FOR NEW CHARACTER
07C6  A463                    IOR    R,WJV3,WJV6           OR IN NEW CHARACTER
07C7  6FF7                    ADD    IS,WJV7,-1            DECREMENT COUNT
07C8  C103 07BD               BRCL   NN,WJ901              KEEP GOING IF MORE CHARACTERS
07CA  6020                    ADD    IS,RET,2              INCREMENT RETURN ADDRESS
07CB  BF07                    BRC    R,7,RET               LEGAL RETURN
                    .
                    .
                    .
                    .
                    .*************************************************************************
                    . ROUTINE TO CHECK A FREQUENCY ENTRY AND MAKE SURE IT IS IN WJ
                    . FREQUENCY LIMITS
                    . ENTRY: WJV2  NUMBER OF CHARACTERS ENTERED
                    .        WJV3 FREQUENCY (LOWER) BCD,1 HZ RESOLUTION
```

```
LOC   OBJECT CODE    CARD IMAGE                                                            CARDNUM
                     .        WJV4 FREQUENCY (UPPER) BCD,1HZ RESOLUTION
                     . EXIT:  WJV3 FREQUENCY (LOWER) BCD,10 HZ RESOLUTION
                     .        WJV4 FREQUENCY (UPPER) BCD,10 HZ RESOLUTICN
                     . RETURN FOR ILLEGAL ENTRY
                     . RETURN+2 FOR LEGAL ENTRY
                     .**********************************************************************
                     .
07CC  2082           WJ91     CMP    IS,WJV2,8          COMPARE WITH MAX COUNT
07CD  BF01                    BRC    R,1,RET            ILLEGAL - TOO MANY
07CE  2062                    CMP    IS,WJV2,6          COMPARE COUNT WITH MIN
07CF  BF04                    BRC    R,4,RET            ILLEGAL - TOO FEW
07D0  E833                    SHD    RL,WJV3,4          POSITION FREQUENCY FOR WJ
07D1  B104 0305               CMP    I,WJV4,0305        COMPARE WITH MAX FREQUENCY
07D3  BF01                    BRC    R,1,RET            ILLEGAL - TOO LARGE
07D4  B104 0005               CMP    I,WJV4,05          COMPARE WITH MIN FREQUENCY
07D6  BF04                    BRC    R,4,RET            ILLEGAL - TOO SMALL
07D7  6020                    ADD    IS,RET,2           INCREMENT RETURN ADDRESS
07D8  BF07                    BRC    R,7,RET            LEGAL RETURN
                     .
                     .
                     .
                     .
                     .**********************************************************************
                     . ROUTINE TO DISPLAY FREQUENCY
                     . WJV1 FREQUENCY (LOWER) IN DISPLAY FORMAT
                     . WJV2 FREQUENCY (UPPER) IN DISPLAY FORMAT
                     .**********************************************************************
                     .
07D9  9C00 09F1      WJ92     STR    D,RET,WJ90R        SAVE RETURN ADDRESS
07DB  E104 3030               LDR    I,WJV4,03030       SET UP ASCII CONVERSION CONSTANT
07DD  4003                    LDR    IS,WJV3,0          CLEAR REGISTER
07DE  F831                    SHD    LL,WJV1,4          SET FREQUENCY TO 1 HZ RESOLUTION
07DF  F832                    SHD    LL,WJV2,4          POSITION 1ST 2 DIGITS
07E0  AE33                    SHS    LL,WJV3,4
07E1  F832                    SHD    LL,WJV2,4
07E2  A443                    IOR    R,WJV3,WJV4        CONVERT TO ASCII
07E3  9C03 0ADD               STR    D,WJV3,WJDF1       PUT 1ST 2 DIGITS IN DISPLAY BUFFER
07E5  4003                    LDR    IS,WJV3,0          CLEAR REGISTER
07E6  F832                    SHD    LL,WJV2,4          POSITION 2ND 2 DIGITS
07E7  AE33                    SHS    LL,WJV3,4
07E8  F832                    SHD    LL,WJV2,4
07E9  A443                    IOR    R,WJV3,WJV4        CONVERT TO ASCII
07EA  9C03 0ADE               STR    D,WJV3,WJDF1+1     PUT IN DISPLAY BUFFER
07EC  4002                    LDR    IS,WJV2,0          CLEAR REGISTER
07ED  F831                    SHD    LL,WJV1,4          POSITION 3RD 2 DIGITS
07EE  AE32                    SHS    LL,WJV2,4
07EF  F831                    SHD    LL,WJV1,4
07F0  A442                    IOR    R,WJV2,WJV4        CONVERT TO ASCII
07F1  9C02 0ADF               STR    D,WJV2,WJDF1+2     PUT IN DISPLAY BUFFER
07F3  4002                    LDR    IS,WJV2,0          CLEAR REGISTER
07F4  F831                    SHD    LL,WJV1,4          POSITION LAST 2 DIGITS
07F5  AE32                    SHS    LL,WJV2,4
07F6  F831                    SHD    LL,WJV1,4
```

```
LOC   OBJECT CODE     CARD IMAGE                                                                    CARDNUM

07F7  A442                  IOR   R,WJV2,WJV4         CONVERT TO ASCII
07F8  9C02 0AE0             STR   D,WJV2,WJDF1+3      PUT IN DISPLAY BUFFER
07FA  E101 0AD8             LDR   I,WJV1,WJDF         GET ADDRESS OF OUTPUT BUFFER
07FC  ED00 0230             BAL   I,RET,OUTPUT        OUTPUT BUFFER
07FE  E200 09F1             LDR   D,RET,WJ90R         GET RETURN ADDRESS
0800  BF07                  BRC   R,7,RET             RETURN TO CALLER
                     .
                     .
                     .
                     .*********************************************************************
                     . ROUTINE TO DISPLAY GAIN MODE AND IF BANDWIDTH
                     . WJV1 GAIN MODE IN DISPLAY FORMAT
                     . WJV2 IF BANDWIDTH IN DISPLAY FORMAT
                     .*********************************************************************
                     .
0801  9C00 09F1      WJ93   STR   D,RET,WJ90R         SAVE RETURN ADDRESS
0803  9C02 09F2             STR   D,WJV2,WJ90S1       SAVE IF BANDWIDTH
0805  9C01 09F3             STR   D,WJV1,WJ90S2       SAVE GAIN MODE
0807  E101 0AFB             LDR   I,WJV1,WJDGM        GET ADDRESS OF BUFFER TO OUTPUT
0809  ED00 0230             BAL   I,RET,OUTPUT        OUTPUT BUFFER
080B  E202 09F3             LDR   D,WJV2,WJ90S2       PUT GAIN MODE IN REG 2
080D  E103 0B27             LDR   I,WJV3,WJGMTB       GET ADDRESS OF GAIN MODE TABLE
080F  5321                  LDR   RX,WJV1,WJV2,WJV3   GET ADDRESS OF BUFFER TO OUTPUT
0810  ED00 0230             BAL   I,RET,OUTPUT        OUTPUT BUFFER
0812  E101 0B03             LDR   I,WJV1,WJDIF        GET ADDRESS OF BUFFER TO OUTPUT
0814  ED00 0230             BAL   I,RET,OUTPUT        OUTPUT BUFFER
0816  E202 09F2             LDR   D,WJV2,WJ90S1       GET IF BANDWIDTH
0818  E103 0B42             LDR   I,WJV3,WJIFTB       GET ADDRESS OF IF BANDWIDTH TABLE
081A  5321                  LDR   RX,WJV1,WJV2,WJV3   GET ADDRESS OF BUFFER TO OUTPUT
081B  ED00 0230             BAL   I,RET,OUTPUT        OUTPUT IF BANDWIDTH BUFFER
081D  E200 09F1             LDR   D,RET,WJ90R         GET RETURN ADDRESS
081F  BF07                  BRC   R,7,RET             RETURN TO CALLER
                     .
                     .
                     .
                     .*********************************************************************
                     . ROUTINE TO DISPLAY DETECT MODE AND BFO FREQUENCY
                     . WJV1 DETECT MODE IN DISPLAY FORMAT
                     . WJV2 BFO FREQUENCY (LOWER) IN DISPLAY FORMAT
                     .*********************************************************************
                     .
0820  9C00 09F1      WJ94   STR   D,RET,WJ90R         SAVE RETURN ADDRESS
0822  9C01 09F2             STR   D,WJV1,WJ90S1       SAVE DETECT MODE
0824  9C02 09F3             STR   D,WJV2,WJ90S2       SAVE BFO FREQUENCY
0826  E101 0AE5             LDR   I,WJV1,WJDDM        GET ADDRESS OF BUFFER TO OUTPUT
0828  ED00 0230             BAL   I,RET,OUTPUT        OUTPUT BUFFER
082A  E202 09F2             LDR   D,WJV2,WJ90S1       GET DETECT MODE
082C  E103 0B61             LDR   I,WJV3,WJDMTB       GET ADDRESS OF DETECT MODE TABLE
082E  5321                  LDR   RX,WJV1,WJV2,WJV3   GET ADDRESS OF BUFFER TO OUTPUT
082F  ED00 0230             BAL   I,RET,OUTPUT        OUTPUT BUFFER
0831  E201 09F3             LDR   D,WJV1,WJ90S2       GET BFO FREQUENCY
```

```
LOC   OBJECT CODE      CARD IMAGE                                                              CARDNUM
0833  4002                    LDR    IS,WJV2,0           CLEAR REGISTER
0834  F831                    SHD    LL,WJV1,4           POSITION UPPER 2 DIGITS
0835  AE32                    SHS    LL,WJV2,4
0836  F831                    SHD    LL,WJV1,4
0837  A502 3030               IOR    I,WJV2,03030        CONVERT TO ASCII
0839  9C02 0AF5               STR    D,WJV2,WJDBF1       STORE IN OUTPUT BUFFER
083B  4002                    LDR    IS,WJV2,0           CLEAR REGISTER
083C  F831                    SHD    LL,WJV1,4           POSITION LOWER 2 DIGITS
083D  AE32                    SHS    LL,WJV2,4
083E  F831                    SHD    LL,WJV1,4
083F  A502 3030               IOR    I,WJV2,03030        CONVERT TO ASCII
0841  9C02 0AF6               STR    D,WJV2,WJDBF1+1     STORE IN OUTPUT BUFFER
0843  E101 0AEE               LDR    I,WJV1,WJDBF        GET ADDRESS OF BUFFER TO OUTPUT
0845  ED00 0230               BAL    I,RET,OUTPUT        OUTPUT BUFFER
0847  E200 09F1               LDR    D,RET,WJ90R         GET RETURN ADDRESS
0849  BF07                    BRC    R,7,RET             RETURN TO CALLER
                       .
                       .
                       .
                       .
                       .*******************************************************************
                       . ROUTINE TO DISPLAY RF GAIN
                       . WJV1 RF GAIN IN DISPLAY FORMAT
                       .*******************************************************************
                       .
C84A  9C00 09F1        WJ95   STR    D,RET,WJ90R         SAVE RETURN ADDRESS
084C  4002                    LDR    IS,WJV2,0           CLEAR REGISTER
084D  F871                    SHD    LL,WJV1,8           POSITION FIRST DIGIT
084E  A502 2030               IOR    I,WJV2,02030        CONVERT TO ASCII
0850  9C02 0B13               STR    D,WJV2,WJDRF1       STORE IN DISPLAY BUFFER
0852  4002                    LDR    IS,WJV2,0           CLEAR REGISTER
0853  F831                    SHD    LL,WJV1,4           POSITION LAST 2 DIGITS
0854  AE32                    SHS    LL,WJV2,4
0855  F831                    SHD    LL,WJV1,4
0856  A502 3030               IOR    I,WJV2,03030        CONVERT TO ASCII
0858  9C02 0B14               STR    D,WJV2,WJDRF1+1     STORE IN DISPLAY BUFFER
085A  E101 0B0D               LDR    I,WJV1,WJDRF        GET ADDRESS OF BUFFER TO OUTPUT
085C  ED00 0230               BAL    I,RET,OUTPUT        OUTPUT BUFFER
085E  E200 09F1               LDR    D,RET,WJ90R         GET RETURN ADDRESS
0860  BF07                    BRC    R,7,RET             RETURN TO CALLER
                       .
                       .
                       .
                       .
                       .*******************************************************************
                       . ROUTINE TO INCREMENT FREQUENCY
                       . WJV1 FREQUENCY IN DISPLAY FORMAT (LOWER)
                       . WJV2 FREQUENCY IN DISPLAY FORMAT (UPPER)
                       . WJV3 FREQUENCY INCREMENT IN DISPLAY FORMAT (LOWER)
                       . WJV4 FREQUENCY INCREMENT IN DISPLAY FORMAT (UPPER)
                       . WJV5 ANSWER FREQUENCY IN DISPLAY FORMAT (LOWER)
                       . WJV6 ANSWER FREQUENCY IN DISPLAY FORMAT (UPPER)
                       .*******************************************************************
```

```
LOC   OBJECT CODE    CARD IMAGE                                                    CARDNUM
                                                                                       691
0861  9C00 09F1   WJ96    STR   D,RET,WJ90R        SAVE RETURN ADDRESS                 692
0863  E109 000F           LDR   I,WJV9,0000F       SET UP MASK                         693
0865  4005                LDR   IS,WJV5,0          CLEAR REGISTER                      694
0866  4006                LDR   IS,WJV6,0          CLEAR REGISTER                      695
0867  E017                LDR   R,WJV7,WJV1        DO 1ST DIGIT                        696
0868  E038                LDR   R,WJV8,WJV3                                            697
0869  ED00 08A4           BAL   I,RET,WJ961                                            698
086B  E075                LDR   R,WJV5,WJV7                                            699
086C  E017                LDR   R,WJV7,WJV1        DO 2ND DIGIT                        700
086D  AD37                SHS   RL,WJV7,4                                              701
086E  8087                ADD   R,WJV7,WJV8                                            702
086F  E038                LDR   R,WJV8,WJV3                                            703
0870  AD38                SHS   RL,WJV8,4                                              704
0871  ED00 08A4           BAL   I,RET,WJ961                                            705
0873  AE37                SHS   LL,WJV7,4                                              706
0874  A475                IOR   R,WJV5,WJV7                                            707
0875  E017                LDR   R,WJV7,WJV1        DO 3RD DIGIT                        708
0876  AD77                SHS   RL,WJV7,8                                              709
0877  8087                ADD   R,WJV7,WJV8                                            710
0878  E038                LDR   R,WJV8,WJV3                                            711
0879  AD78                SHS   RL,WJV8,8                                              712
087A  ED00 08A4           BAL   I,RET,WJ961                                            713
087C  AE77                SHS   LL,WJV7,8                                              714
087D  A475                IOR   R,WJV5,WJV7                                            715
087E  E017                LDR   R,WJV7,WJV1        DO 4TH DIGIT                        716
087F  ADB7                SHS   RL,WJV7,12                                             717
0880  8087                ADD   R,WJV7,WJV8                                            718
0881  E038                LDR   R,WJV8,WJV3                                            719
0882  ADB8                SHS   RL,WJV8,12                                             720
0883  ED00 08A4           BAL   I,RET,WJ961                                            721
0885  AEB7                SHS   LL,WJV7,12                                             722
0886  A475                IOR   R,WJV5,WJV7                                            723
0887  E027                LDR   R,WJV7,WJV2        DO 5TH DIGIT                        724
0888  8087                ADD   R,WJV7,WJV8                                            725
0889  E048                LDR   R,WJV8,WJV4                                            726
088A  ED00 08A4           BAL   I,RET,WJ961                                            727
088C  E076                LDR   R,WJV6,WJV7                                            728
088D  E027                LDR   R,WJV7,WJV2        DO 6TH DIGIT                        729
088E  AD37                SHS   RL,WJV7,4                                              730
088F  8087                ADD   R,WJV7,WJV8                                            731
0890  E048                LDR   R,WJV8,WJV4                                            732
0891  AD38                SHS   RL,WJV8,4                                              733
0892  ED00 08A4           BAL   I,RET,WJ961                                            734
0894  AE37                SHS   LL,WJV7,4                                              735
0895  A476                IOR   R,WJV6,WJV7                                            736
0896  E027                LDR   R,WJV7,WJV2        DO 7TH DIGIT                        737
0897  AD77                SHS   RL,WJV7,8                                              738
0898  8087                ADD   R,WJV7,WJV8                                            739
0899  E048                LDR   R,WJV8,WJV4                                            740
089A  AD78                SHS   RL,WJV8,8                                              741
089B  ED00 08A4           BAL   I,RET,WJ961                                            742
089D  AE77                SHS   LL,WJV7,8                                              743
```

```
LOC    OBJECT CODE     CARD IMAGE                                                              CARDNUM

089E   A476                    IOR    R,WJV6,WJV7
089F   AEB8                    SHS    LL,WJV8,12         DO LAST DIGIT
08A0   A486                    IOR    R,WJV6,WJV8
08A1   E200 09F1               LDR    D,RET,WJ90R        GET RETURN ADDRESS
08A3   BF07                    BRC    R,7,RET            RETURN

08A4   A097           WJ961    AND    R,WJV7,WJV9        CLEAR ALL BUT DIGIT
08A5   A098                    AND    R,WJV8,WJV9        CLEAR ALL BUT DIGIT
08A6   8087                    ADD    R,WJV7,WJV8        ADD DIGITS TOGETHER
08A7   4008                    LDR    IS,WJV8,0          CLEAR REGISTER
08A8   20A7                    CMP    IS,WJV7,10         COMPARE WITH DECIMAL 10
08A9   C104 08AD               BRCL   LT,WJ962           LESS - NO CARRY
08AB   6F67                    ADD    IS,WJV7,-10        DECREMENT ANSWER BY 10
08AC   4018                    LDR    IS,WJV8,1          CARRY ONE
08AD   BF07           WJ962    BRC    R,7,RET            RETURN TO CALLER
                      .
                      .
                      .
                      .
                      .*************************************************************************
                      . SEND START CODE TO RECEIVER
                      . SEND CONTROL WORD TO RECEIVER
                      . SEND END CODE TO RECEIVER
                      .*************************************************************************
                      .
08AE   B60B 09AE      WJS      LLC    D,WJXX,WJCRS       XAR  FOR RCVR CHECK
08E0   B603 09B0               LLC    D,WJX1,WJCRD1      XAR FOR CONTROL WORD ONE
08E2   B604 09B1               LLC    D,WJX2,WJCRD2      XAR FOR CONTROL WORD TWO
08E4   B605 09B2               LLC    D,WJX3,WJCRD3          "      "      "   THREE
08E6   B606 09B3               LLC    D,WJX4,WJCRD4          "      "      "   FOUR
08B8   B602 09AF               LLC    D,WJXE,WJCRE       XAR FOR END OF LOAD
08BA   E207 09C8               LDR    D,WJD1,WJCW1       CONTROL WORD ONE
08BC   E208 09C9               LDR    D,WJD2,WJCW2       TWO
08BE   E209 09CA               LDR    D,WJD3,WJCW3       THREE
08C0   E20A 09CB               LDR    D,WJD4,WJCW4       FOUR
08C2   D937                    ROUT   WJD1,WJX1          SEND DATA WORD 1
08C3   D948                    ROUT   WJD2,WJX2          SEND DATA WORD 2
08C4   D959                    ROUT   WJD3,WJX3          SEND DATA WORD 3
08C5   D96A                    ROUT   WJD4,WJX4          SEND DATA WORD 4
08C6   8CB1           WJS1     RIN    WJV1,WJXX          INPUT RCVR CHECK WORD
08C7   E20F 09F5               LDR    D,WJLPC,WJLPL      LOAD COUNTER
08C9   601F                    ADD    IS,WJLPC,01        INCREMENT COUNTER
08CA   B10F 0014               CMP    I,WJLPC,20         COMPARE WITH 32 TIMES
08CC   C103 09A4               BRCL   GE,WJCKF           BRANCH IF GREATER OR EQUAL
08CE   9C0F 09F5               STR    D,WJLPC,WJLPL      SAVE COUNT
08D0   9E01 0001               CMPL   I,WJV1,01          CHECK TO SEE IF READY
08D2   C105 08C6               BRCL   NE,WJS1            LOOP IF NOT READY
08D4   D921                    ROUT   WJV1,WJXE          SEND TRIGGER
08D5   400F                    LDR    IS,WJLPC,0         ZERO COUNTER
08D6   9C0F 09F5               STR    D,WJLPC,WJLPL      STORE COUNT
08D8   E20F 09F6               LDR    D,WJLPC,WJLPK      LOAD WJS COUNTER
08DA   601F                    ADD    IS,WJLPC,01        INCREMENT COUNTER
08DB   B10F 0005               CMP    I,WJLPC,05         FIVE TIMES THROUGH?
```

```
LOC   OBJECT CODE     CARD IMAGE                                                              CARDNUM

08DD  C103 09A4             BRCL  GE,WJCKF            YES-EXIT / NO-CONTINUE                     797
08DF  9C0F 09F6             STR   D,WJLPC,WJLPK       SAVE COUNT                                 798
                      .                                                                          799
                      .                                                                          800
                      .                                                                          801
                      .                                                                          802
                      .*******************************************************************       803
                      . SEND 'START TO SEND' CODE TO RECEIVER                                    804
                      . GET CONTROL WORD FROM RECEIVER                                           805
                      . SEND 'END OF SEND' TO RECEIVER                                           806
                      . CONVERT RECEIVED WORD TO DISPLAY FORMAT                                  807
                      .*******************************************************************       808
                      .                                                                          809
08E1  9C00 09F1       WJR   STR   D,RET,WJ90R         SAVE RETURN ADDRESS                        810
08E3  B60B 09AE             LLC   D,WJXX,WJCRS        XAR FOR RECEIVER CHECK                     811
08E5  B601 09B9             LLC   D,WJXS,WJRCB        XAR  TO START LOAD/STOP MON CLK            812
08E7  B603 09B5             LLC   D,WJX1,WJRCD1       XAR FOR CONTROL WORD ONE                   813
08E9  B604 09B6             LLC   D,WJX2,WJRCD2       TWO                                        814
08EB  B605 09B7             LLC   D,WJX3,WJRCD3       THREE                                      815
08ED  B606 09B8             LLC   D,WJX4,WJRCD4       FOUR                                       816
08EF  B602 09BA             LLC   D,WJXE,WJRCE        XAR TO END INPUT/START MON CLK             817
08F1  8CB7            WJR1  RIN   WJD1,WJXX           INPUT CHECK                                818
08F2  E20F 09F5             LDR   D,WJLPC,WJLPL       LOAD COUNTER                               819
08F4  601F                  ADD   IS,WJLPC,01         INCREMENT COUNTER                          820
08F5  B10F 0014             CMP   I,WJLPC,20          COMPARE WITH 32 TIMES                      821
08F7  C103 09A4             BRCL  GE,WJCKF            BRANCH IF GREATER OR EQUAL                 822
08F9  9C0F 09F5             STR   D,WJLPC,WJLPL       SAVE COUNT                                 823
08FB  9E07 0001             CMPL  I,WJD1,01           CHECK TO SEE IF READY                      824
08FD  C105 08F1             BRCL  NE,WJR1             LOOP IF NOT READY                          825
08FF  D917                  ROUT  WJD1,WJXS           STOP MONITOR CLOCK                         826
0900  8C37                  RIN   WJD1,WJX1           INPUT FIRST CONTROL WORD                   827
0901  8C48                  RIN   WJD2,WJX2           SECOND                                     828
0902  8C59                  RIN   WJD3,WJX3           THIRD                                      829
0903  8C6A                  RIN   WJD4,WJX4           FOURTH                                     830
0904  D927                  ROUT   WJD1,WJXE          START MONITOR CLOCK                        831
0905  9C37 09CC             STRM  D,WJD1,WJRS1,4      STORE RECEIVED DATA WORDS                  832
0907  E201 09F4             LDR   D,WJV1,CHKFLG1      LOAD REG 1 FOR CHECK                       833
0909  9E01 0001             CMPL  I,WJV1,01           CHECK FOR COMMAND 6                        834
090B  C102 0921             BRCL  EQ,WJR2             COMMAND 6=BRANCH                           835
090D  E204 09C8             LDR   D,WJV4,WJCW1        CONTROL WORD ONE                           836
090F  E205 09C9             LDR   D,WJV5,WJCW2        TWO                                        837
0911  E206 09CA             LDR   D,WJV6,WJCW3        THREE                                      838
0913  B047                  CMP   R,WJD1,WJV4         COMPARE SENT AND RECEIVED WORDS 1          839
0914  C105 08AE             BRCL  NE,WJS              NOT THE SAME-SEND AGAIN                    840
0916  B058                  CMP   R,WJD2,WJV5         COMPARE 2                                  841
0917  C105 08AE             BRCL  NE,WJS              NOT THE SAME-SEND AGAIN                    842
0919  B069                  CMP   R,WJD3,WJV6         COMPARE 3                                  843
091A  C105 08AE             BRCL  NE,WJS              NOT THE SAME-SEND AGAIN                    844
091C  400F                  LDR   IS,WJLPC,0          ZERO COUNTER                               845
091D  9C0F 09F5             STR   D,WJLPC,WJLPL       STORE COUNT                                846
091F  9C0F 09F6             STR   D,WJLPC,WJLPK       SAVE COUNT                                 847
0921  E202 09CC       WJR2  LDR   D,WJV2,WJRS1        GET FREQUENCY UPPER                        848
0923  E201 09CD             LDR   D,WJV1,WJRS2        GET FREQUENCY LOWER                        849
```

```
LOC   OBJECT CODE    CARD IMAGE                                                         CARDNUM

0925  E831                SHD   RL,WJV1,4          POSITION FREQUENCY FOR DISPLAY             850
0926  A102 03FF           AND   I,WJV2,03FF        CLEAR ALL BUT FREQUENCY                    851
0928  9C01 09E0           STR   D,WJV1,WJRFL       STORE IN RECEIVED DISPLAY (LOWER)          852
092A  9C02 09E1           STR   D,WJV2,WJRFU       STORE IN RECEIVED DISPLAY (UPPER)          853
092C  E201 09CD           LDR   D,WJV1,WJRS2       GET RECEIVED WORD 2                        854
092E  A101 000C           AND   I,WJV1,0C          CLEAR ALL BUT GAIN MODE                    855
0930  AD11                SHS   RL,WJV1,2          POSITION GAIN MODE                         856
0931  9C01 09E5           STR   D,WJV1,WJRGM       STORE IN RECEIVED GAIN MODE FOR DISP       857
0933  E201 09CE           LDR   D,WJV1,WJRS3       GET RECEIVED WORD 3                        858
0935  E202 09CD           LDR   D,WJV2,WJRS2       GET RECEIVED WORD 2                        859
0937  F801                SHD   LL,WJV1,1          POSITION RECEIVED BANDWIDTH                860
0938  A102 0007           AND   I,WJV2,07          CLEAR ALL BUT BANDWIDTH                    861
093A  9C02 09E7           STR   D,WJV2,WJRIF       STORE IN RECEIVED DISPLAY                  862
093C  A101 E000           AND   I,WJV1,0E000       CLEAR ALL BUT DETECT MODE                  863
093E  ADC1                SHS   RL,WJV1,13         POSITION DETECT MODE                       864
093F  9C01 09E2           STR   D,WJV1,WJRDM       STORE IN RECEIVED DISPLAY                  865
0941  E101 0004           LDR   I,WJV1,04          GET BFO UPPER DISPLAY                      866
0943  9C01 09E4           STR   D,WJV1,WJRBU       STORE IN RECEIVED DISPLAY                  867
0945  E201 09CE           LDR   D,WJV1,WJRS3       GET RECEIVED BFO FREQUENCY                 868
0947  A101 07FF           AND   I,WJV1,07FF        CLEAR ALL BUT BFO FREQUENCY                869
0949  4002                LDR   IS,WJV2,0          CLEAR REG 2                                870
094A  CD01 07D0           MUL   I,WJV1,07D0        MULTIPLY BY 2000                           871
094C  E103 07FF           LDR   I,WJV3,07FF        LOAD DIVISOR                               872
094E  8101 0400           ADD   I,WJV1,0400        ROUND                                      873
0950  FC31                DIV   R,WJV1,WJV3        DIVIDE                                     874
0951  8102 1194           ADD   I,WJV2,01194       ADD 4500                                   875
0953  4003                LDR   IS,WJV3,0          CLEAR REG 3                                876
0954  40A4                LDR   IS,WJV4,10         SET UP DIVISOR                             877
0955  FC42                DIV   R,WJV2,WJV4        DIVIDE BY 10                               878
0956  E021                LDR   R,WJV1,WJV2        PUT REMAINDER IN WJV1 AS 1ST DIGIT         879
0957  E032                LDR   R,WJV2,WJV3        GET QUOTIENT                               880
0958  4003                LDR   IS,WJV3,0          CLEAR REGISTER                             881
0959  FC42                DIV   R,WJV2,WJV4        DIVIDE BY 10                               882
095A  AE32                SHS   LL,WJV2,4          POSITION 2ND DIGIT                         883
095B  A421                IOR   R,WJV1,WJV2        PUT 2ND DIGIT IN ANSWER                    884
095C  E032                LDR   R,WJV2,WJV3        GET QUOTIENT                               885
095D  4003                LDR   IS,WJV3,0          CLEAR REGISTER                             886
095E  FC42                DIV   R,WJV2,WJV4        DIVIDE BY 10                               887
095F  AE72                SHS   LL,WJV2,8          POSITION 3RD DIGIT                         888
0960  AEB3                SHS   LL,WJV3,12         POSITION 4TH DIGIT                         889
0961  A421                IOR   R,WJV1,WJV2        PUT IN 3RD DIGIT                           890
0962  A431                IOR   R,WJV1,WJV3        PUT IN 4TH DIGIT                           891
0963  9C01 09E3           STR   D,WJV1,WJRBL       STORE IN RECEIVED BFO FREQ DISPLAY (       892
0965  E202 09CF           LDR   D,WJV2,WJRS4       GET RECEIVED WORD 4                        893
0967  A102 7F00           AND   I,WJV2,07F00       CLEAR ALL BUT RF GAIN                      894
0969  AD72                SHS   RL,WJV2,8          RIGHT JUSTIFY                              895
096A  B421                LLC   R,WJV1,WJV2        COMPLEMENT                                 896
096B  A101 007F           AND   I,WJV1,07F         CLEAR ALL BUT RF GAIN                      897
096D  ED00 097C           BAL   I,RET,WJR3         CONVERT TO BCD PERCENTAGE                  898
096F  9C01 09E6           STR   D,WJV1,WJRRFG      STORE IN RECEIVED DISPLAY                  899
0971  E201 09CF           LDR   D,WJV1,WJRS4       GET RECEIVED WORD 4                        900
0973  A101 007F           AND   I,WJV1,07F         CLEAR ALL BUT SIGNAL STRENGTH              901
0975  ED00 097C           BAL   I,RET,WJR3         CONVERT TO BCD PERCENTAGE                  902
```

```
LOC   OBJECT CODE     CARD IMAGE                                                                  CARDNUM

0977  9C01 09E9              STR   D,WJV1,WJRSS          STORE IN RECEIVED DISPLAY
0979  E200 09F1              LDR   D,RET,WJ90R           GET RETURN ADDRESS
097B  BF07                   BRC   R,7,RET               RETURN TO CALLER

097C  CD01 0064     WJR3     MUL   I,WJV1,064            MULTIPLY BY 100
097E  6371                   ADD   IS,WJV1,037           ROUND
097F  47F3                   LDR   IS,WJV3,07F           SET UP DIVISOR
0980  FC31                   DIV   R,WJV1,WJV3           DIVIDE BY 127
0981  E021                   LDR   R,WJV1,WJV2           PUT DIVIDEND IN REG 1
0982  4002                   LDR   IS,WJV2,0             CLEAR REGISTER
0983  40A3                   LDR   IS,WJV3,10            SET UP DIVISOR
0984  FC31                   DIV   R,WJV1,WJV3           DIVIDE BY 10
0985  E014                   LDR   R,WJV4,WJV1           PUT REMAINDER IN REG 4 (DIGIT 1)
0986  E021                   LDR   R,WJV1,WJV2           SET UP DIVIDEND
0987  4002                   IDR   IS,WJV2,0             CLEAR REGISTER
0988  FC31                   DIV   R,WJV1,WJV3           DIVIDE BY 10
0989  AE31                   SHS   LL,WJV1,4             POSITION 2ND DIGIT
098A  AE72                   SHS   LL,WJV2,8             POSITION 3RD DIGIT
098B  A441                   IOR   R,WJV1,WJV4           COMBINE 1ST AND 2ND DIGITS
098C  A421                   IOR   R,WJV1,WJV2           COMBINE ALL DIGITS
098D  BF07                   BRC   R,7,RET               RETURN TO CALLER
                    .
                    .
                    .
                    .*************************************************************************
                    . BCD TO HEX ROUTINE (4 DIGIT BCD VALUE)
                    . BCD VALUE PASSED IN WJV2
                    . HEX VALUE RETURNED IN WJV1
                    . ROUTINE USES WJV1,WJV2,WJV3,WJV4
                    .*************************************************************************
                    .
098E  E021          WJBCDH   LDR   R,WJV1,WJV2           LOAD LEAST SIGNIFICANT BITS, PART 1
098F  A101 000F              AND   I,WJV1,0F               "     "       "       "  , PART 2
0991  AD32                   SHS   RL,WJV2,4             SHIFT FOR MULTIPLICATION
0992  E023                   LDR   R,WJV3,WJV2           LOAD DUMMY REG FOR MULTIPLICATION
0993  A103 000F              AND   I,WJV3,15             CLEAR ALL BUT LEAST SIG BITS
0995  CD03 000A              MUL   I,WJV3,10             MULTIPLY BY 16
0997  8031                   ADD   R,WJV1,WJV3           ADD ONTO ANSWER
0998  AD32                   SHS   RL,WJV2,4             SHIFT FOR MULTIPLICATION
0999  E023                   LDR   R,WJV3,WJV2           LOAD DUMMY REG FOR MULTIPLICATION
099A  A103 000F              AND   I,WJV3,15             CLEAR ALL BUT LEAST SIG BITS
099C  CD03 0064              MUL   I,WJV3,064            MULTIPLY BY 100
099E  8031                   ADD   R,WJV1,WJV3           ADD ONTO ANSWER
099F  AD32                   SHS   RL,WJV2,4             SHIFT FOR MULTIPLICATION
09A0  CD02 03E8              MUL   I,WJV2,03E8           MULTIPLY BY 1000
09A2  8021                   ADD   R,WJV1,WJV2           ADD ONTO ANSWER
09A3  BF07                   BRC   R,7,RET               RETURN TO CALLER
                    .
                    .
                    .
                             EAGE
```

```
LOC   OBJECT CODE    CARD IMAGE                                                                     CARDNUM

                     .                                                                                  955
                     . ******************************                                                   956
                     .  ROUTINE TO OUTPUT LOOP MESSAGE                                                  957
                     . ******************************                                                   958
09A4  E101 0BD2      WJCKP     LDR    I,WJV1,WJCP         LOAD ADDRESS OF OUTPUT                        959
09A6  400F                     LDR    IS,WJLPC,0          ZERO COUNTER                                  960
09A7  9C0F 09F6                STR    D,WJLPC,WJLPK       SAVE ZERO COUNT                               961
09A9  ED00 0230                BAL    I,RET,OUTPUT        OUTPUT LOOP BUFFER                            962
09AB  C107 0519                BRCL   U,WJ02              RETURN TO RECEIVER CONTROL                    963
                     .                                                                                  964
                     .                                                                                  965
                     .                                                                                  966
                     .                                                                                  967
                     .*********************************************************************            968
                     . DATA BUFFERS                                                                     969
                     .*********************************************************************            970
                     .                                                                                  971
                     . RETURN ADDRESS                                                                   972
09AD                 WJRET     DS     1                   SAVE RETURN ADDRESS                           973
                     .                                                                                  974
                     . XAR ADDRESSES                                                                    975
09AE  2300           WJCRS     DC     02300               XAR TO DETERMINE IF RECEIVER IS READY         976
09AF  2000           WJCRE     DC     02000               XAR FOR COMPLETION OF SEND/TRIGGER            977
09B0  2010           WJCRD1    DC     02010               XAR OUTPUT CONTROL WORD ONE                   978
09B1  2020           WJCRD2    DC     02020               XAR OUT TWO                                   979
09B2  2030           WJCRD3    DC     02030               XAR OUT THREE                                 980
09B3  2100           WJCRD4    DC     02100               XAR OUT FOUR                                  981
09B4  2330           WJCRF     DC     02330               DISABLE RECEIVER                              982
09B5  2230           WJRCD1    DC     02230               XAR INPUT CONTROL WORD ONE                    983
09B6  2220           WJRCD2    DC     02220               XAR IN TWO                                    984
09B7  2210           WJRCD3    DC     02210               XAR IN THREE                                  985
09B8  2200           WJRCD4    DC     02200               XAR IN FOUR                                   986
09B9  2110           WJRCB     DC     02110               XAR TO START INPUT/STOP MONITOR CLOCK         987
09BA  2120           WJRCE     DC     02120               XAR END INPUT/START MONITOR CLOCK             988
09BB  2130           WJCRO     DC     02130               ENABLE RECEIVER XAR                           989
                     .                                                                                  990
                     . INITIAL CONTROL WORD                                                             991
09BC  0055           WJI1      DC     00055               INITIAL CONTROL WORD 1                        992
09BD  000A           WJI2      DC     0000A               INITIAL CONTROL WORD 2                        993
09BE  0400           WJI3      DC     00400               INITIAL CONTROL WORD 3                        994
09BF  0000           WJI4      DC     00000               INITIAL CONTROL WORD 4                        995
                     .                                                                                  996
                     . INITIAL CONTROL WORD - DISPLAY FORMAT                                            997
09C0  5000           WJICD     DC     05000               CONTROL FREQUENCY (LOWER)                     998
09C1  0005                     DC     00005               CONTROL FREQUENCY (UPPER)                     999
09C2  0000                     DC     0                   CONTROL DETECT MODE                          1000
09C3  5500                     DC     05500               CONTROL BFO FREQUENCY  (LOWER)               1001
09C4  0004                     DC     04                  CONTROL BFO FREQUENCY  (UPPER)               1002
09C5  0002                     DC     00002               CONTROL GAIN MODE                            1003
09C6  0100                     DC     0100                CONTROL RF GAIN                              1004
09C7  0004                     DC     04                  CONTROL IF BANDWIDTH                         1005
                     .                                                  *                              1006
                     . CONTROL WORD                                                                    1007
```

```
LOC   OBJECT CODE    CARD IMAGE                                                              CARDNUM

09C8                 WJCW1    DS    1                 RCVR CONTROL WORD 1                    1008
09C9                 WJCW2    DS    1                                   2                    1009
09CA                 WJCW3    DS    1                                   3                    1010
09CB                 WJCW4    DS    1                                   4                    1011
                     .                                                                       1012
                     . RECEIVED WORD FROM WJ                                                 1013
09CC                 WJRS1    DS    1                 RCVR SENT WORD 1                       1014
09CD                 WJRS2    DS    1                                2                       1015
09CE                 WJRS3    DS    1                                3                       1016
09CF                 WJRS4    DS    1                                4                       1017
                     .                                                                       1018
                     . TENTATIVE VALUES - DISPLAY FORMAT                                     1019
09D0                 WJTFL    DS    1                 TENTATIVE FREQ(LOWER)                  1020
09D1                 WJTFU    DS    1                 TENTATIVE FREQ(UPPER)                  1021
09D2                 WJTDM    DS    1                 TENTATIVE DETECT MODE                  1022
09D3                 WJTBL    DS    1                 TENTATIVE !FO FREQ(LOWER)              1023
09D4                 WJTBU    DS    1                 TENTATIVE BFO FREQ (UPPER)             1024
09D5                 WJTGM    DS    1                 TENTATIVE GAIN MODE                    1025
09D6                 WJTRFG   DS    1                 TENTATIVE RF GAIN                      1026
09D7                 WJTIF    DS    1                 TENTATIVE IF BANDWIDTH                 1027
                     .                                                                       1028
                     . CONTROI VALUES - DISPLAY FORMAT                                       1029
09D8                 WJCFL    DS    1                 CONTROL FREQUENCY (LOWER)              1030
09D9                 WJCFU    DS    1                 CONTROL FREQUENCY (UPPER)              1031
09DA                 WJCDM    DS    1                 CONTROL DETECT MODE                    1032
09DB                 WJCBL    DS    1                 CONTROL BFO FREQUENCY  (LOWER)         1033
09DC                 WJCBU    DS    1                 CONTROL BFO FREQUENCY  (UPPER)         1034
09DD                 WJCGM    DS    1                 CONTROL GAIN MODE                      1035
09DE                 WJCRFG   DS    1                 CONTROL RF GAIN                        1036
09DF                 WJCIF    DS    1                 CONTROL IF BANDWIDTH                   1037
                     .                                                                       1038
                     . RECEIVED VALUES - DISPLAY FORMAT                                      1039
09E0                 WJRFL    DS    1                 RECEIVED FREQUENCY (LOWER)             1040
09E1                 WJRFU    DS    1                 RECEIVED FREQUENCY (UPPER)             1041
09E2                 WJRDM    DS    1                 RECEIVED DETECT MODE                   1042
09E3                 WJRBL    DS    1                 RECEIVED BFO FREQUENCY  (LOWER)        1043
09E4                 WJRBU    DS    1                 RECEIVED BFO FREQUENCY  (UPPER)        1044
09E5                 WJRGM    DS    1                 RECEIVED GAIN MODE                     1045
09F6                 WJRRFG   DS    1                 RECEIVED RF GAIN                       1046
09E7                 WJRIF    DS    2                 RECEIVED IF BANDWIDTH                  1047
09E9                 WJRSS    DS    1                 RECEIVED SIGNAL STRENGTH               1048
                     .                                                                       1049
                     .                                                                       1050
                     . SCAN VARIABLES                                                        1051
09EA                 WJSFUU   DS    1                 UPPER LIMIT  (UPPER)                   1052
09EB                 WJSFUL   DS    1                 UPPER LIMIT  (LOWER)                   1053
09EC                 WJSFLU   DS    1                 LOWER LIMIT  (UPPER)                   1054
09ED                 WJSFLL   DS    1                 LOWER LIMIT  (LOWER)                   1055
09EE                 WJSFIN   DS    1                 FREQUENCY INCREMENT (8 KHZ MAX)        1056
09EF                 WJSFSS   DS    1                 SIGNAL STRENGTH                        1057
09F0                 WJSCNT   DS    1                 COUNT OF NUMBER OF SCAN PASSES         1058
                     .                                                                       1059
                     . SAVE LOCATIONS FOR ALL WJ9- ROUTINES                                  1060
```

```
LOC   OBJECT CODE    CARD IMAGE                                                       CARDNUM

09F1              WJ90R    DS    1                                                    1061
09F2              WJ90S1   DS    1                                                    1062
09F3              WJ90S2   DS    1                                                    1063
09F4              CHKFIG1  DS    1            FLAG FOR COMMAND 6                      1064
09F5              WJLPL    DS    1            LOOP COUNTER STORAGE                    1065
09F6              WJLPK    DS    1            WJS COUNTER STORAGE                     1066
                  .                                                                   1067
                  . RECEIVER CONTROL TITLE BUFFER                                     1068
09F7  0009        WJT      DC    9            RECEIVER CONTROL TITLE                  1069
09F8  0D0A                 DC    00D0A        CR/LF                                   1070
09F9  5245                 DC    05245        RE                                      1071
09FA  4345                 DC    04345        CE                                      1072
09FB  4956                 DC    04956        IV                                      1073
09FC  4552                 DC    04552        ER                                      1074
09FD  2043                 DC    02043         C                                      1075
09FE  4F4E                 DC    04F4E        ON                                      1076
09FF  5452                 DC    05452        TR                                      1077
0A00  4F4C                 DC    04F4C        OL                                      1078
0A01  0000                 DC    0            NULL                                    1079
                  .                                                                   1080
                  .                                                                   1081
                  . COMMANDS BUFFER                                                   1082
0A02  0047        WJINS    DC    71                                                   1083
0A03  303D                 DC    0303D        0=                                      1084
0A04  5345                 DC    05345        SE                                      1085
0A05  542D                 DC    0542D        T-                                      1086
0A06  5550                 DC    05550        UP                                      1087
0A07  0D0A                 DC    00D0A        CR/LF                                   1088
0A08  313D                 DC    0313D        1=                                      1089
0A09  4449                 DC    04449        DI                                      1090
0A0A  5350                 DC    05350        SP                                      1091
0A0B  4C41                 DC    04C41        LA                                      1092
0A0C  5920                 DC    05920        Y                                       1093
0A0D  5445                 DC    05445        TE                                      1094
0A0E  4E54                 DC    04E54        NT                                      1095
0A0F  4154                 DC    04154        AT                                      1096
0A10  4956                 DC    04956        IV                                      1097
0A11  450D                 DC    0450D        E/CR                                    1098
0A12  0A32                 DC    00A32        LF/2                                    1099
0A13  3D44                 DC    03D44        =D                                      1100
0A14  4953                 DC    04953        IS                                      1101
0A15  504C                 DC    0504C        PL                                      1102
0A16  4159                 DC    04159        AY                                      1103
0A17  2043                 DC    02043         C                                      1104
0A18  4F4E                 DC    04F4E        ON                                      1105
0A19  5452                 DC    05452        TR                                      1106
0A1A  4F4C                 DC    04F4C        OL                                      1107
0A1B  0D0A                 DC    00D0A        CR/LF                                   1108
0A1C  333D                 DC    0333D        3=                                      1109
0A1D  4449                 DC    04449        DI                                      1110
0A1E  5350                 DC    05350        SP                                      1111
0A1F  4C41                 DC    04C41        LA                                      1112
0A20  5920                 DC    05920        Y                                       1113
```

```
LOC   OBJECT CODE     CARD IMAGE                                   CARDNUM
0A21  5245                  DC     05245          RE                  1114
0A22  4345                  DC     04345          CE                  1115
0A23  4956                  DC     04956          IV                  1116
0A24  4544                  DC     04544          ED                  1117
0A25  0D0A                  DC     00D0A          CR/LF               1118
0A26  343D                  DC     0343D          4=                  1119
0A27  454E                  DC     0454E          EN                  1120
0A28  5445                  DC     05445          TE                  1121
0A29  5220                  DC     05220          R                   1122
0A2A  5445                  DC     05445          TE                  1123
0A2B  4E54                  DC     04E54          NT                  1124
0A2C  4154                  DC     04154          AT                  1125
0A2D  4956                  DC     04956          IV                  1126
0A2E  450D                  DC     0450D          E/CR                1127
0A2F  0A35                  DC     00A35          LF/5                1128
0A30  3D53                  DC     03D53          =S                  1129
0A31  4341                  DC     04341          CA                  1130
0A32  4E20                  DC     04E20          N                   1131
0A33  0D0A                  DC     00D0A          CR/LF               1132
0A34  363D                  DC     0363D          6=                  1133
0A35  5245                  DC     05245          RE                  1134
0A36  4345                  DC     04345          CE                  1135
0A37  4956                  DC     04956          IV                  1136
0A38  4520                  DC     04520          E                   1137
0A39  434F                  DC     0434F          CO                  1138
0A3A  4E54                  DC     04E54          NT                  1139
0A3B  524F                  DC     0524F          RO                  1140
0A3C  4C20                  DC     04C20          L                   1141
0A3D  0D0A                  DC     00D0A          CR/LF               1142
0A3E  373D                  DC     0373D          7=                  1143
0A3F  444F                  DC     0444F          DO                  1144
0A40  4E45                  DC     04E45          NE                  1145
0A41  0D0A                  DC     00D0A          CR/LF               1146
0A42  383D                  DC     0383D          8=                  1147
0A43  5245                  DC     05245          RE                  1148
0A44  494E                  DC     0494E          IN                  1149
0A45  4954                  DC     04954          IT                  1150
0A46  494C                  DC     0494C          IL                  1151
0A47  495A                  DC     0495A          IZ                  1152
0A48  4520                  DC     04520          E                   1153
0A49  0D0A                  DC     00D0A          CR/LF               1154
0A4A  0000                  DC     0              NULL                1155
                      .                                               1156
                      . FREQUENCY TITLE BUFFER                        1157
0A4B  0006            WJFB  DC     6              COUNT               1158
0A4C  4652                  DC     04652          FR                  1159
0A4D  4551                  DC     04551          EQ                  1160
0A4E  2028                  DC     02028           (                  1161
0A4F  485A                  DC     0485A          HZ                  1162
0A50  2920                  DC     02920          )                   1163
0A51  0D0A                  DC     00D0A          CR/LF               1164
0A52  0000                  DC     0              NULL                1165
                      .                                               1166
```

```
LOC    OBJECT CODE     CARD IMAGE                                          CARDNUM

                      . GAIN MODE TITLE BUFFER                              1167
0A53   0018           WJGMB     DC     24            COUNT                  1168
0A54   4741                     DC     04741         GA                     1169
0A55   494E                     DC     0494E         IN                     1170
0A56   204D                     DC     0204D          M                     1171
0A57   4F44                     DC     04F44         OD                     1172
0A58   450D                     DC     0450D         ECR                    1173
0A59   0A30                     DC     00A30         LF0                    1174
0A5A   3D48                     DC     03D48         =H                     1175
0A5B   4F4C                     DC     04F4C         OL                     1176
0A5C   4420                     DC     04420         D                      1177
0A5D   4147                     DC     04147         AG                     1178
0A5E   430D                     DC     0430D         CCR                    1179
0A5F   0A32                     DC     00A32         LF2                    1180
0A60   3D4E                     DC     03D4E         =N                     1181
0A61   4F52                     DC     04F52         OR                     1182
0A62   4D41                     DC     04D41         MA                     1183
0A63   4C20                     DC     04C20         L                      1184
0A64   4147                     DC     04147         AG                     1185
0A65   430D                     DC     0430D         CCR                    1186
0A66   0A33                     DC     00A33         LF3                    1187
0A67   3D4D                     DC     03D4D         =M                     1188
0A68   414E                     DC     0414E         AN                     1189
0A69   5541                     DC     05541         UA                     1190
0A6A   4C20                     DC     04C20         L                      1191
0A6B   0D0A                     DC     00D0A         CR/LF                  1192
0A6C   0000                     DC     0             NULL                   1193
                      .                                                     1194
                      . IF BANDWIDTH TITLE BUFFER                           1195
0A6D   001A           WJIFB     DC     26            COUNT                  1196
0A6E   4946                     DC     04946         IF                     1197
0A6F   2042                     DC     02042          B                     1198
0A70   414E                     DC     0414E         AN                     1199
0A71   4457                     DC     04457         DW                     1200
0A72   4944                     DC     04944         ID                     1201
0A73   5448                     DC     05448         TH                     1202
0A74   0D0A                     DC     00D0A         CR/LF                  1203
0A75   313D                     DC     0313D         1=                     1204
0A76   3530                     DC     03530         50                     1205
0A77   3020                     DC     03020         0                      1206
0A78   485A                     DC     0485A         HZ                     1207
0A79   0D0A                     DC     00D0A         CR/LF                  1208
0A7A   323D                     DC     0323D         2=                     1209
0A7B   3220                     DC     03220         2                      1210
0A7C   4B48                     DC     04B48         KH                     1211
0A7D   5A0D                     DC     05A0D         ZCR                    1212
0A7E   0A33                     DC     00A33         LF3                    1213
0A7F   3D34                     DC     03D34         =4                     1214
0A80   204B                     DC     0204B          K                     1215
0A81   485A                     DC     0485A         HZ                     1216
0A82   0D0A                     DC     00D0A         CR/LF                  1217
0A83   343D                     DC     0343D         4=                     1218
0A84   3820                     DC     03820         8                      1219
```

```
LOC   OBJECT CODE     CARD IMAGE                                        CARDNUM

0A85  4B48                   DC     04B48            KH                  1220
0A86  5A20                   DC     05A20            Z                   1221
0A87  0D0A                   DC     00D0A            CR/LF               1222
0A88  0000                   DC     0                NULL                1223
                      .                                                  1224
                      . DETECT MODE TITLE BUFFER                         1225
0A89  0028            WJDMB  DC     40               COUNT               1226
0A8A  4445                   DC     04445            DE                  1227
0A8B  5445                   DC     05445            TE                  1228
0A8C  4354                   DC     04354            CT                  1229
0A8D  204D                   DC     0204D             M                  1230
0A8E  4F44                   DC     04F44            OD                  1231
0A8F  450D                   DC     0450D            ECR                 1232
0A90  0A30                   DC     00A30            LF0                 1233
0A91  3D41                   DC     03D41            =A                  1234
0A92  4D0D                   DC     04D0D            MCR                 1235
0A93  0A31                   DC     00A31            LF1                 1236
0A94  3D46                   DC     03D46            =F                  1237
0A95  4D0D                   DC     04D0D            MCR                 1238
0A96  0A32                   DC     00A32            LF2                 1239
0A97  3D42                   DC     03D42            =B                  1240
0A98  464F                   DC     0464F            FO                  1241
0A99  2046                   DC     02046             F                  1242
0A9A  4958                   DC     04958            IX                  1243
0A9B  4544                   DC     04544            ED                  1244
0A9C  0D0A                   DC     00D0A            CR/LF               1245
0A9D  333D                   DC     0333D            3=                  1246
0A9E  4246                   DC     04246            BF                  1247
0A9F  4F20                   DC     04F20            O                   1248
0AA0  5641                   DC     05641            VA                  1249
0AA1  520D                   DC     0520D            RCR                 1250
0AA2  0A34                   DC     00A34            LF4                 1251
0AA3  3D49                   DC     03D49            =I                  1252
0AA4  5342                   DC     05342            SB                  1253
0AA5  0D0A                   DC     00D0A            CR/LF               1254
0AA6  353D                   DC     0353D            5=                  1255
0AA7  4C53                   DC     04C53            LS                  1256
0AA8  420D                   DC     0420D            BCR                 1257
0AA9  0A36                   DC     00A36            LF6                 1258
0AAA  3D55                   DC     03D55            =U                  1259
0AAB  5342                   DC     05342            SB                  1260
0AAC  0D0A                   DC     00D0A            CR/LF               1261
0AAD  373D                   DC     0373D            7=                  1262
0AAE  414D                   DC     0414D            AM                  1263
0AAF  2D4E                   DC     02D4E            -N                  1264
0AB0  4C20                   DC     04C20            L                   1265
0AB1  0D0A                   DC     00D0A            CR/LF               1266
0AB2  0000                   DC     0                NULL                1267
                      .                                                  1268
                      . BFO FREQUENCY TITLE BUFFER                       1269
0AB3  0015            WJBFB  DC     21               COUNT               1270
0AB4  4246                   DC     04246            BF                  1271
0AB5  4F20                   DC     04F20            O                   1272
```

```
LOC    OBJECT CODE     CARD IMAGE                                                CARDNUM

0AB6   4652                      DC     04652          FR                          1273
0AB7   4551                      DC     04551          EQ                          1274
0AB8   2028                      DC     02028           (                          1275
0AB9   485A                      DC     0485A          HZ                          1276
0ABA   2920                      DC     02920          )                           1277
0ABB   0D0A                      DC     00D0A          CR/LF                       1278
0ABC   3434                      DC     03434          44                          1279
0ABD   3520                      DC     03520          5                           1280
0ABE   4B48                      DC     04B48          KH                          1281
0ABF   5A20                      DC     05A20          Z                           1282
0AC0   544F                      DC     0544F          TO                          1283
0AC1   2034                      DC     02034           4                          1284
0AC2   3635                      DC     03635          65                          1285
0AC3   204B                      DC     0204B           K                          1286
0AC4   485A                      DC     0485A          HZ                          1287
0AC5   2049                      DC     02049           I                          1288
0AC6   4E20                      DC     04E20          N                           1289
0AC7   485A                      DC     0485A          HZ                          1290
0AC8   0D0A                      DC     00D0A          CR/LF                       1291
0AC9   0000                      DC     0              NULL                        1292
                       .                                                           1293
                       .RF GAIN  TITLE  BUFFER                                     1294
0ACA   000C            WJRFGB    DC     12             COUNT                       1295
0ACB   5246                      DC     05246          RF                          1296
0ACC   2047                      DC     02047           G                          1297
0ACD   4149                      DC     04149          AI                          1298
0ACE   4E0D                      DC     04E0D          NCR                         1299
0ACF   0A28                      DC     00A28          LF(                         1300
0AD0   5045                      DC     05045          PE                          1301
0AD1   5243                      DC     05243          RC                          1302
0AD2   454E                      DC     0454E          EN                          1303
0AD3   5441                      DC     05441          TA                          1304
0AD4   4745                      DC     04745          GE                          1305
0AD5   2920                      DC     02920          )                           1306
0AD6   0D0A                      DC     00D0A          CR/LF                       1307
0AD7   0000                      DC     0              NULL                        1308
                       .                                                           1309
                       . FREQUENCY TITLE FOR DISPLAY                               1310
0AD8   000B            WJDF      DC     11             COUNT                       1311
0AD9   4652                      DC     04652          FR                          1312
0ADA   4551                      DC     04551          EQ                          1313
0ADB   203D                      DC     0203D           =                          1314
0ADC   2020                      DC     02020                                      1315
0ADD   2020            WJDF1     DC     02020          XX                          1316
0ADE   2020                      DC     02020          XX                          1317
0ADF   2020                      DC     02020          XX                          1318
0AE0   2020                      DC     02020          XX                          1319
0AE1   2048                      DC     02048           H                          1320
0AE2   5A20                      DC     05A20          Z                           1321
0AE3   0D0A                      DC     00D0A          CR/LF                       1322
0AE4   0000                      DC     0              NULL                        1323
                       .                                                           1324
                       . DETECT MODE TITLE FOR DISPLAY                             1325
```

```
LOC   OBJECT CODE     CARD IMAGE                                                   CARDNUM

0AE5  0007            WJDDM    DC     7                   COUNT                      1326
0AE6  4445                     DC     04445               DE                         1327
0AE7  5445                     DC     05445               TE                         1328
0AE8  4354                     DC     04354               CT                         1329
0AE9  204D                     DC     0204D                M                         1330
0AEA  4F44                     DC     04F44               OD                         1331
0AEB  4520                     DC     04520               E                          1332
0AEC  3D20                     DC     03D20               =                          1333
0AED  0000                     DC     0                   NULL                       1334
                      .                                                              1335
                      . BFO FREQUENCY TITLE FOR DISPLAY                              1336
0AEE  000B            WJDBF    DC     11                  COUNT                      1337
0AEF  4246                     DC     04246               BF                         1338
0AF0  4F20                     DC     04F20               O                          1339
0AF1  4652                     DC     04652               FR                         1340
0AF2  4551                     DC     04551               EQ                         1341
0AF3  203D                     DC     0203D                =                         1342
0AF4  2034                     DC     02034                4                         1343
0AF5  2020            WJDBF1   DC     02020               XX                         1344
0AF6  2020                     DC     02020               XX                         1345
0AF7  3020                     DC     03020               0                          1346
0AF8  485A                     DC     0485A               HZ                         1347
0AF9  0D0A                     DC     00D0A               CR/LF                      1348
0AFA  0000                     DC     0                   NULL                       1349
                      .                                                              1350
                      . GAIN MODE TITLE FOR DISPLAY                                  1351
0AFB  0006            WJDGM    DC     6                   COUNT                      1352
0AFC  4741                     DC     04741               GA                         1353
0AFD  494E                     DC     0494E               IN                         1354
0AFE  204D                     DC     0204D                M                         1355
0AFF  4F44                     DC     04F44               OD                         1356
0B00  4520                     DC     04520               E                          1357
0B01  3D20                     DC     03D20               =                          1358
0B02  0000                     DC     0                   NULL                       1359
                      .                                                              1360
                      . IF BANDWIDTH TITLE FOR DISPLAY                               1361
0B03  0008            WJDIF    DC     8                   COUNT                      1362
0B04  4946                     DC     04946               IF                         1363
0B05  2042                     DC     02042                B                         1364
0B06  414E                     DC     0414E               AN                         1365
0B07  4457                     DC     04457               DW                         1366
0B08  4944                     DC     04944               ID                         1367
0B09  5448                     DC     05448               TH                         1368
0B0A  203D                     DC     0203D                =                         1369
0B0B  2020                     DC     02020                                          1370
0B0C  0000                     DC     0                   NULL                       1371
                      .                                                              1372
                      . RF GAIN TITLE FOR DISPLAY                                    1373
0B0D  0009            WJDRF    DC     9                   COUNT                      1374
0B0E  5246                     DC     05246               RF                         1375
0B0F  2047                     DC     02047                G                         1376
0B10  4149                     DC     04149               AI                         1377
0B11  4E20                     DC     04E20               N                          1378
```

```
IOC   OBJECT CODE    CARD IMAGE                                                 CARDNUM

0B12  3D20                  DC     03D20          =                                1379
0B13  2020          WJDRF1  DC     02020          XX                               1380
0B14  2020                  DC     02020          XX                               1381
0B15  2520                  DC     02520          %                                1382
0B16  0D0A                  DC     00D0A          CR/LF                            1383
0B17  0000                  DC     0              NULL                             1384
                    .                                                              1385
                    . SIGNAL STRENGTH TITLE FOR DISPLAY                            1386
0B18  000D          WJDSS   DC     13             COUNT                            1387
0B19  5349                  DC     05349          SI                               1388
0B1A  474E                  DC     0474E          GN                               1389
0B1B  414C                  DC     0414C          AL                               1390
0B1C  2053                  DC     02053           S                               1391
0B1D  5452                  DC     05452          TR                               1392
0B1E  454E                  DC     0454E          EN                               1393
0B1F  4754                  DC     04754          GT                               1394
0B20  4820                  DC     04820          H                                1395
0B21  3D20                  DC     03D20          =                                1396
0B22  2020          WJDSS1  DC     02020          XX                               1397
0B23  2020                  DC     02020          XX                               1398
0B24  2520                  DC     02520          %                                1399
0B25  0D0A                  DC     0D0A           CR/LF                            1400
0B26  0000                  DC     0              NULL                             1401
                    .                                                              1402
                    . TABLE OF GAIN MODES FOR DISPLAY                              1403
0B27  0B2B          WJGMTB  DC     WJGM0          HOLD AGC                         1404
0B28  0B32                  DC     WJGM1          NOT USED                         1405
0B29  0B34                  DC     WJGM2          NORMAL AGC                       1406
0B2A  0B3C                  DC     WJGM3          MANUAL                           1407
                    .                                                              1408
                    .                                                              1409
0B2B  0005          WJGM0   DC     5              COUNT/HOLD AGC                   1410
0B2C  484F                  DC     0484F          HO                               1411
0B2D  4C44                  DC     04C44          LD                               1412
0B2E  2041                  DC     02041           A                               1413
0B2F  4743                  DC     04743          GC                               1414
0B30  0D0A                  DC     00D0A          CR/LF                            1415
0B31  0000                  DC     0              NULL                             1416
                    .                                                              1417
                    .                                                              1418
0B32  FFFF          WJGM1   DC     -1             COUNT/INVALID ENTRY              1419
0B33  0000                  DC     0              NULL                             1420
                    .                                                              1421
                    .                                                              1422
0B34  0006          WJGM2   DC     6              COUNT/NORMAL AGC                 1423
0B35  4E4F                  DC     04E4F          NO                               1424
0B36  524D                  DC     0524D          RM                               1425
0B37  414C                  DC     0414C          AL                               1426
0B38  2041                  DC     02041           A                               1427
0B39  4743                  DC     04743          GC                               1428
0B3A  0D0A                  DC     00D0A          CR/LF                            1429
0B3B  0000                  DC     0              NULL                             1430
                    .                                                              1431
```

```
LOC   OBJECT CODE     CARD IMAGE                                                                   CARDNUM
                       .                                                                              1432
0B3C  0004            WJGM3     DC      4                  COUNT/MANUAL                               1433
0B3D  4D41                      DC      04D41              MA                                         1434
0B3E  4E55                      DC      04E55              NU                                         1435
0B3F  414C                      DC      0414C              AL                                         1436
0B40  0D0A                      DC      00D0A              CR/LF                                      1437
0B41  0000                      DC      0                  NULL                                       1438
                       .                                                                              1439
                       . TABLE CF IF BANDWIDTHS FOR DISPLAY                                           1440
0B42  0B47            WJIFIB    DC      WJIF0              NOT USED                                   1441
0B43  0B49                      DC      WJIF1              500HZ                                      1442
0B44  0B4F                      DC      WJIF2              2KHZ                                       1443
0B45  0B55                      DC      WJIF3              4KHZ                                       1444
0B46  0B5B                      DC      WJIF4              8KHZ                                       1445
                       .                                                                              1446
                       .                                                                              1447
0B47  FFFF            WJIF0     DC      -1                 COUNT/INVALID ENTRY                        1448
0B48  0000                      DC      0                  NULL                                       1449
                       .                                                                              1450
                       .                                                                              1451
0B49  0004            WJIF1     DC      4                  COUNT/500KHZ                               1452
0B4A  3530                      DC      03530              50                                         1453
0B4B  3020                      DC      03020              0                                          1454
0B4C  485A                      DC      0485A              HZ                                         1455
0B4D  0D0A                      DC      00D0A              CR/LF                                      1456
0B4E  0000                      DC      0                  NULL                                       1457
                       .                                                                              1458
                       .                                                                              1459
0B4F  0004            WJIF2     DC      4                  COUNT/2KHZ                                 1460
0B50  3220                      DC      03220              2                                          1461
0B51  4B48                      DC      04B48              KH                                         1462
0B52  5A20                      DC      05A20              Z                                          1463
0B53  0D0A                      DC      00D0A              CR/LD                                      1464
0B54  0000                      DC      0                  NULL                                       1465
                       .                                                                              1466
                       .                                                                              1467
0B55  0004            WJIF3     DC      4                  COUNT/4KHZ                                 1468
0B56  3420                      DC      03420              4                                          1469
0B57  4B48                      DC      04B48              KH                                         1470
0B58  5A20                      DC      05A20              Z                                          1471
0B59  0D0A                      DC      00D0A              CR/LF                                      1472
0B5A  0000                      DC      0                  NULL                                       1473
                       .                                                                              1474
                       .                                                                              1475
0B5B  0004            WJIF4     DC      4                  COUNT/8 KHZ                                1476
0B5C  3820                      DC      03820              8                                          1477
0B5D  4B48                      DC      04B48              KH                                         1478
0B5E  5A20                      DC      05A20              Z                                          1479
0B5F  0D0A                      DC      00D0A              CR/LF                                      1480
0B60  0000                      DC      0                  NULL                                       1481
                       .                                                                              1482
                       . TABLE CF DETECT MODES FOR DISPLAY                                            1483
0B61  0B69            WJDMTB    DC      WJDM1              AM                                         1484
```

```
LOC   OBJECT CODE    CARD IMAGE                                      CARDNUM
0E62  0B6D                  DC    WJDM2          FM                     1485
0B63  0B71                  DC    WJDM3          BFO FIXED              1486
0B64  0B79                  DC    WJDM4          BFO VARIABLE           1487
0B65  0B82                  DC    WJDM5          ISB                    1488
0B66  0B87                  DC    WJDM6          LSB                    1489
0E67  0B8C                  DC    WJDM7          USB                    1490
0B68  0B91                  DC    WJDM8          AM-NL                  1491
                     .                                                  1492
                     .                                                  1493
0B69  0002           WJDM1  DC    2              COUNT/AM               1494
0B6A  414D                  DC    0414D          AM                     1495
0B6B  0D0A                  DC    00D0A          CR/LF                  1496
0B6C  0000                  DC    0              NULL                   1497
                     .                                                  1498
                     .                                                  1499
0B6D  0002           WJDM2  DC    2              COUNT/FM               1500
0B6E  464D                  DC    0464D          FM                     1501
0B6F  0D0A                  DC    00D0A          CR/LF                  1502
0B70  0000                  DC    0              NULL                   1503
                     .                                                  1504
                     .                                                  1505
0B71  0006           WJDM3  DC    6              COUNT/BFO FIXED        1506
0B72  4246                  DC    04246          BF                     1507
0B73  4F20                  DC    04F20          O                      1508
0B74  4649                  DC    04649          FI                     1509
0B75  5845                  DC    05845          XE                     1510
0B76  4420                  DC    04420          D                      1511
0B77  0D0A                  DC    00D0A          CR/LF                  1512
0B78  0000                  DC    0              NULL                   1513
                     .                                                  1514
                     .                                                  1515
0B79  0007           WJDM4  DC    7              COUNT/BFO VARIAFLE     1516
0B7A  4246                  DC    04246          BF                     1517
0B7B  4F20                  DC    04F20          O                      1518
0B7C  5641                  DC    05641          VA                     1519
0B7D  5249                  DC    05249          RI                     1520
0B7E  4142                  DC    04142          AB                     1521
0B7F  4C45                  DC    04C45          LE                     1522
0B80  0D0A                  DC    00D0A          CR/LF                  1523
0B81  0000                  DC    0              NULL                   1524
                     .                                                  1525
                     .                                                  1526
0B82  0003           WJDM5  DC    3              COUNT/ISB              1527
0B83  4953                  DC    04953          IS                     1528
0B84  4220                  DC    04220          B                      1529
0B85  0D0A                  DC    00D0A          CR/LF                  1530
0B86  0000                  DC    0              NULL                   1531
                     .                                                  1532
                     .                                                  1533
0B87  0003           WJDM6  DC    3              COUNT/LSB              1534
0B88  4C53                  DC    04C53          LS                     1535
0B89  4220                  DC    04220          B                      1536
0B8A  0D0A                  DC    00D0A          CR/LF                  1537
```

```
LOC   OBJECT CODE     CARD IMAGE                                   CARDNUM
0B8B  0000                     DC     0        NULL                  1538
                      .                                              1539
                      .                                              1540
0B8C  0003            WJDM7    DC     3        COUNT/USB             1541
0B8D  5553                     DC     05553    US                    1542
0B8E  4220                     DC     04220    B                     1543
0B8F  0D0A                     DC     00D0A    CR/LF                 1544
0B90  0000                     DC     0        NULL                  1545
                      .                                              1546
                      .                                              1547
0B91  0004            WJDM8    DC     4        COUNT/AM-NL           1548
0B92  414D                     DC     0414D    AM                    1549
0B93  2D4E                     DC     02D4E    -N                    1550
0B94  4C20                     DC     04C20    L                     1551
0B95  0D0A                     DC     00D0A    CR/LF                 1552
0B96  0000                     DC     0        NULL                  1553
                      .                                              1554
                      . SCAN TITLE                                   1555
0B97  0003            WJSCAN   DC     3        COUNT                 1556
0B98  5343                     DC     05343    SC                    1557
0B99  414E                     DC     0414E    AN                    1558
0B9A  0D0A                     DC     00D0A    CR/LF                 1559
0B9B  0000                     DC     0        NULL                  1560
                      .                                              1561
                      . START FREQUENCY TITLE                        1562
0B9C  0009            WJSFS    DC     9        COUNT                 1563
0B9D  5354                     DC     05354    ST                    1564
0B9E  4152                     DC     04152    AR                    1565
0B9F  5420                     DC     05420    T                     1566
0BA0  4652                     DC     04652    FR                    1567
0BA1  4551                     DC     04551    EQ                    1568
0BA2  2049                     DC     02049     I                    1569
0BA3  4E20                     DC     04E20    N                     1570
0BA4  485A                     DC     0485A    HZ                    1571
0BA5  0D0A                     DC     00D0A    CR/LF                 1572
0BA6  0000                     DC     0        NULL                  1573
                      .                                              1574
                      . END FREQUENCY TITLE                          1575
0BA7  0008            WJSFE    DC     8        COUNT                 1576
0BA8  454E                     DC     0454E    EN                    1577
0BA9  4420                     DC     04420    D                     1578
0BAA  4652                     DC     04652    FR                    1579
0BAB  4551                     DC     04551    EQ                    1580
0BAC  2049                     DC     02049     I                    1581
0BAD  4E20                     DC     04E20    N                     1582
0BAE  485A                     DC     0485A    HZ                    1583
0BAF  0D0A                     DC     00D0A    CR/LF                 1584
0BB0  0000                     DC     0        NULL                  1585
                      .                                              1586
                      . FREQUENCY INCREMENT TITLE                    1587
0BB1  000B            WJSFI    DC     11       COUNT                 1588
0BB2  4652                     DC     04652    FR                    1589
0BB3  4551                     DC     04551    EQ                    1590
```

```
LOC    OBJECT CODE     CARD IMAGE                                                      CARDNUM

0BB4   2049                    DC      02049         I                                   1591
0BB5   4E43                    DC      04E43         NC                                  1592
0BB6   5245                    DC      05245         RE                                  1593
0BB7   4D45                    DC      04D45         ME                                  1594
0BB8   4E54                    DC      04E54         NT                                  1595
0BB9   2049                    DC      02049          I                                  1596
0BBA   4E20                    DC      04E20         N                                   1597
0BBB   485A                    DC      0485A         HZ                                  1598
0BBC   0D0A                    DC      00D0A         CR/LF                               1599
0BBD   0000                    DC      0             NULL                                1600
                       .                                                                 1601
                       . SIGNAL STRENGTH TITLE                                           1602
0BBE   000A            WJSSS   DC      10            COUNT                               1603
0BBF   5349                    DC      05349         SI                                  1604
0BC0   474E                    DC      0474E         GN                                  1605
0BC1   414C                    DC      0414C         AL                                  1606
0BC2   2053                    DC      02053          S                                  1607
0BC3   5452                    DC      05452         TR                                  1608
0BC4   454E                    DC      0454E         EN                                  1609
0BC5   4754                    DC      04754         GT                                  1610
0BC6   4820                    DC      04820         H                                   1611
0BC7   2520                    DC      02520         %                                   1612
0BC8   0D0A                    DC      00D0A         CR/LF                               1613
0BC9   0000                    DC      0             NULL                                1614
                       .                                                                 1615
                       . NO FIND MESSAGE FOR SCAN                                        1616
0BCA   0006            WJSNF   DC      6             COUNT                               1617
0BCB   4E4F                    DC      04E4F         NO                                  1618
0BCC   2053                    DC      02053          S                                  1619
0BCD   4947                    DC      04947         IG                                  1620
0BCE   4E41                    DC      04E41         NA                                  1621
0BCF   4C20                    DC      04C20         L                                   1622
0BD0   0D0A                    DC      00D0A         CR/LF                               1623
0BD1   0000                    DC      0             NULL                                1624
                       .                                                                 1625
                       .                                                                 1626
                       .  LOOP MESSAGE                                                   1627
0BD2   001D            WJCF    DC      29            COUNT                               1628
0BD3   0707                    DC      00707         BELL BELL                           1629
0BD4   494E                    DC      0494E         IN                                  1630
0BD5   4649                    DC      04649         FI                                  1631
0BD6   4E49                    DC      04E49         NI                                  1632
0BD7   5445                    DC      05445         TE                                  1633
0BD8   204C                    DC      0204C          L                                  1634
0BD9   4F4F                    DC      04F4F         OO                                  1635
0BDA   500D                    DC      0500D         PCR                                 1636
0BDB   0A5D                    DC      00A5D         LFP                                 1637
0BDC   4C45                    DC      04C45         LE                                  1638
0BDD   4153                    DC      04153         AS                                  1639
0BDE   4520                    DC      04520         E                                   1640
0BDF   4348                    DC      04348         CH                                  1641
0BE0   4543                    DC      04543         EC                                  1642
0BE1   4B20                    DC      04B20         K                                   1643
```

```
LOC    OBJECT CODE      CARD IMAGE                                                  CARDNUM

0EE2   494E                   DC      0494E          IN                              1644
0BE3   5445                   DC      05445          TE                              1645
0BE4   5246                   DC      05246          RF                              1646
0BE5   4143                   DC      04143          AC                              1647
0BE6   4520                   DC      04520          E                               1648
0EE7   414E                   DC      0414E          AN                              1649
0BE8   4420                   DC      04420          D                               1650
0BE9   5245                   DC      05245          RE                              1651
0BEA   4345                   DC      04345          CE                              1652
0BEB   4956                   DC      04956          IV                              1653
0BEC   4552                   DC      04552          ER                              1654
0BED   C707                   DC      00707          BELL BELL                       1655
0BEE   0D0A                   DC      00D0A          CR/LF                           1656
0BEF   0000                   DC      0000           NULL                            1657
                                                                                     1658
                              PAGE                                                   1659
```

BIBLIOGRAPHY

1. Applied Technology Airborne Computer, v. 1, Principles of Operation, Itek Corp., 1974.

2. Applied Technology Airborne Computer, v. 7, Input/Output Description, Itek Corp., 1974.

3. Applied Technology Airborne Computer, v. 8, Assembler/Loader, Itek Corp., 1974.

4. Instruction Manual for WJ-8888 HF Receiver, Watkins Johnson Co., 1975.

5. Rosenberger, D. K., Signal Acquisition and Sampling using a Microprocessor, M.S. Thesis, United States Naval Postgraduate School, 1977.

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Documentation Center Cameron Station Alexandria, Virginia 22314	2
2.	Library, Code 0212 Naval Postgraduate School Monterey, California 93940	2
3.	Professor D. E. Kirk, Code 62Ki Department Chairman Department of Electrical Engineering Naval Postgraduate School Monterey, California 93940	1
4.	Associate Professor Stephen Jauregui, Jr. Code 62Ja Department of Electrical Engineering Naval Postgraduate School Monterey, California 93940	10
5.	LT. William Glenn Borries, USN 2593 Lipton Road Columbus, Ohio 43227	1
6.	Watkins Johnson Company 700 Quince Orchard Road Gaithesburg, Maryland 20760 ATTN: Roy Scherer	1
7.	Applied Technology 645 Alamanor Avenue Sunnyvale, California 94086 ATTN: Ira Spector	1

8. Commander Naval Electronics Systems Command 3
PME-107
Washington, D.C. 20360
ATTN: Mr. R. LeSage
Capt. W. Flowers
Mr. P. Lowell

9. Commander Naval Security Group Command 1
G-82
3801 Nebraska Avenue
Washington, D.C. 20390
ATTN: CDR. Shoemaker

10. Watkins Johnson Company 1
3333 Hillview Avenue
Palo Alto, California 94304
ATTN: Mr. T. Harper

Thesis 169908
B7148 Borries
c.1 An interactive computer interface with a digital receiver.